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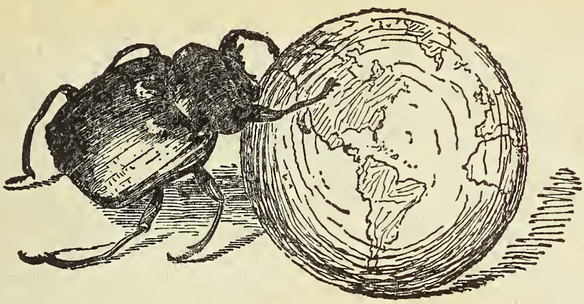

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ON FORMICID NOMENCLATURE

By William Steel Creighton

College of the City of New York

For a number of years the author has had under consideration certain proposals which might aid in simplifying our unwieldy system of formicid nomenclature. The need for improvement has been evident to all who have struggled with our intricate pentanomial designations. I had supposed, however, that myrmecologists themselves understood the system well enough to avoid being confused by its complexity. I am no longer sure that this is the case since there has come to my attention a short paper from the pen of A. C. Cole[1] which indicates that the present status of formicid nomenclature is so intricate that even some students of ants fail to appreciate its varied ramifications. Thus Cole confounds the obvious need for nomenclatorial simplification with what he seems to regard as inherently chaotic taxonomy. I can put no other interpretation upon several of his statements, one of which is as follows:

"It is apparent that in order to prevent the classification of Formicidæ from attaining a more chaotic condition, the rules of nomenclature must be followed more conscientiously. The rather vague and unsatisfactory methods of the past must be discarded and replaced by thoroughly scientific procedure."

[1] Cole, A. C. "Suggestions Concerning Taxonomic Nomenclature of the Hymenopterous Family Formicidæ, etc." The Amer. Midland Entomologist, Vol. 19, No. 1, p. 236–241 (1938).

It is no purpose of mine to appear as an apologist for formicid taxonomy. Anyone who has taken the trouble to familiarize himself with the field will appreciate that it is in little need of defense. It may be truly stated that there are few other families of insects in which conservative taxonomic practice has been more generally or more carefully followed. It is largely because of this hyperconservatism that our present nomenclatorial difficulties have arisen. But, while it may be agreed that our nomenclature is involved, this by no means implies that the taxonomy on which it rests is chaotic. On the contrary it is obvious that students of ant taxonomy, in common with those who deal with other families of social insects, enjoy advantages inherent in social organisms. The inevitable variability of any long series from a single nest makes for conservatism in dealing with variation. When it is so readily apparent that the offspring of a single female may show considerable variation or, in the polymorphic species, may be wholly unlike, a natural check is placed upon the evaluation of differences which appear in new material. Furthermore the large series available to the descriptor has facilitated the exchange of type material. There is seldom an occasion where the author of a species cannot supply other workers with cotypes from the original nest series. The stabilizing effect on the field is too obvious to require comment. In the face of such facts anyone who contends that ant taxonomy is chaotic is merely demonstrating his ignorance of the true conditions.

I further find myself at odds with Cole in his contention that myrmecologists have violated the rules of nomenclature. This opinion is implied in the paragraph quoted above but finds full expression in the opening lines of Cole's paper which I quote:

"The writer is convinced that authors of descriptions of new ants who deal with categories less than species have very often violated our accepted rules of nomenclature. The status of a great many described kinds of ants is definitely insecure at present because of these inaccuracies."

It may be admitted that the use of infra-specific names in myrmecology is a peculiar one but this does not justify Cole's charge. Carlo Emery appears to have been the first to employ two infra-specific ranks with the variety subordinated to the subspe-

cies. I take it that this is the practice to which Cole objects. It may be pointed out, however, that there is nothing in the International Rules of Nomenclature that forbids such procedure which was an accepted rule of myrmecological nomenclature years before the International Rules were adopted. Nor can I see where this method is inaccurate. Emery was an exceptionally careful observer and he appreciated the fact that variations which occur within a species are not always of the same degree of magnitude. Emery therefore used the term variety to apply to very minor differences and the term subspecies to apply to the differences of somewhat greater magnitude. If this method is inaccurate I count myself no judge of accuracy. The question of its expediency from a nomenclatorial standpoint is wholly another thing. It is this aspect of the matter that I wish to discuss in the present paper.

Formicid taxonomy is usually spoken of as a pentanomial system because it employs four categories below the genus. These are subgenus, species, subspecies and variety. It might with equal propriety be called a hexanomial system for, in addition to the four recognized categories just cited, there is a fifth known as the "group." As yet the group has not made its appearance in formal nomenclatorial designations for the obvious reason that it is always designated by a specific name. Thus we have the *rufa* group in the genus Formica which may be distinguished from the *sanguinea, microgyna, exsecta* and *fusca* groups in the same genus. This arrangement is valuable for indicating relationships and, since it does not add any burden to the nomenclature, there is no reason to discard the practice. Similar considerations apply to the subgenus which may be employed in consonance with an abbreviated generic notation that does not add undue nomenclatorial burden. As the subgenus and the group are by no means myrmecological monopolies I take it that taxonomists in other fields have also found these groupings useful. On the other hand I believe, and trust, that our method of handling the subspecies and the variety is a unique taxonomic phenomenon. Although as originally envisaged the plan for the use of two infra-specific ranks was wholly conservative the unforeseen end result has been to complicate the nomenclature to such an extent that conservatism seems

apt to perish in a situation of its own devising. It may, therefore, be instructive to follow the steps by which this singular situation arose. The introduction of infra-specific ranks into the field of myrmecology is the joint contribution of Emery and Forel. Prior to the appearance of these two workers formicid taxonomy had been dominated by Gustav Mayr, a man whose invaluable contributions have been overshadowed by the more voluminous writings of his successors. Mayr's ability for generic delimitation has never been surpassed and it may be added that as early as 1861 he was able to produce a very creditable system of classification covering most of the European ant fauna without recourse to a single infra-specific name. This condition was not to last. It is difficult to ascertain the first appearance of the infra-specific unit. It is certain, however, that by 1874 Forel had definitely embarked on a course of specific subdivision. His *Fourmis de la Suisse,* which appeared in that year, lists numerous "races" assigned to species with which they showed relationship. Emery was not slow to follow Forel's lead and at first used the same term to apply to such forms. About 1885, however, Emery threw over Forel's term race and employed a new but equivalent one, the variety. Up to this point no particular difficulty in nomenclature had arisen. All infra-specific units, whether races or varieties, were assumed to be of equal rank. A trinomial was, therefore, the limit to which terminology could go. In the early 1890's Emery began to draw a distinction between such units. He introduced a new rank, which he called the subspecies, and discriminated between the status of this form and that of the variety. The effect of this novelty upon Forel was at once noticeable. Although he did not accept Emery's term subspecies for more than ten years he immediately recognized the existence of a second infra-specific rank. Forel appears to have had a soft spot in his heart for his own term race. At least he continued to employ it to apply to any infra-specific variant. Thus in his writings from 1895 to 1905 there are numerous references to races which are varieties and races which are "stirps." This last was a term adopted by Forel to designate the subspecific rank. At length Forel was won over to Emery's terminology and, since Wheeler had followed Emery's plan from the start, by 1910 we find the three dominant

figures in the field of myrmecology supporting the present system of infra-specific nomenclature. Support in this case did not mean that the system was accepted as wholly satisfactory. In 1913, when Wheeler published his book *Ants,* he discussed the shortcomings of the arrangement and in that volume followed a practice which was, in effect, a return to binomial nomenclature. Two years later Donisthorpe in his book *British Ants* reduced his nomenclature to a trinomial status by elevating subspecies to specific rank. Under other circumstances such efforts might have produced more general results. That they did not is unquestionably an outcome of the publication of the formicid section of the *Genera Insectorum.* Throughout this colossal work Emery adhered to the pentanomial system. The magnitude of his contribution was so great that further dissent was stifled. Hence we find myrmecologists struggling to control a situation which with each succeeding publication becomes more unmanageable.

Much has been claimed for the supposed phyletic value of the pentanomial system. The worth of this claim appears to have been considerably overestimated. Although the following remarks are restricted to the three lower categories, the species, subspecies and the variety, they will apply with equal cogency to the higher categories as well. When we write *F. rufa* subsp. *integroides* var. *coloradensis* Wheeler how much phylogeny is expressed? Not a great deal, for all that we are doing is to give a very partial view of a much more intricate series of relationships. True the system shows that the variety *coloradensis* "belongs" to the subspecies *integroides* but this, in itself, is apt to create an erroneous impression. Rather we should say that the subspecies *integroides* exists only as a combination of the seven varieties of which it is composed. Bear in mind that each of these varieties is supposed to show the same subspecific characteristic which delimits the group and, hence, all are coequal as regards this character. It may be admitted that one variant bears the distinction of having been first described. It is therefore not usually given its full name which would be subsp. *integroides* var. *integroides* but is simply designated as the "typical" *integroides.* Typical of what? Surely not of any phyletic consideration for in this particular there is no typical form. All seven variants are phyletically equal and to

demark one of them on the purely taxonomic basis of priority is to destroy whatever phyletic value the arrangement may have. Yet I do not believe that I am overstating the case when I say that after years of standing such "typical" subspecies acquire, in the minds of many myrmecologists, the status of stem forms. The same considerations apply to the relationship between subspecies and species. There are eight described subspecies clustered under the sheltering wing of the "typical" *rufa*. Unless one stops to remember that the "typical" *rufa* itself constitutes the ninth subspecies in the complex and is "typical" only because Linnaeus happened to describe it before any of the others were recognized, a faulty phyletic impression results. I contend that the pentanomial system is more apt to cause phyletic confusion than the reverse.

If we admit, as I think we must, that the pentanomial system is undesirable both from the standpoint of nomenclature and phyletics what remedial measures are possible? We may follow Donisthorpe's lead and elevate all the subspecies to specific rank. It may surprise those who regard the late W. M. Wheeler as a champion of the pentanomial system to learn that he favored this method. In 1935 he wrote me as follows:

"Of late I have been trying to get rid of many of the subspecies and varieties of ants by elevating them to species and subspecies, kicking them upstairs so to speak, largely because the nomenclature is becoming too complicated."

While one must heartily agree to the truth of this last statement it may be questioned that the proposed solution is entirely satisfactory. It places a value on the subspecies which some myrmecologists would hesitate to accept. I do not doubt that both Wheeler and Donisthorpe had in mind the supposed "specific incipience" of the subspecies. It has been held that subspecies are a sort of embryonic species which can be hatched into the adult condition either by natural selection or by the help of the taxonomist. For a number of reasons this latter sort of incubation seems more apt to be effective. Not the least among these is the utility of this rank as a repository for questionable forms. Into it could be dropped those confusing variants whose status as separate species might be called in question. As "incipient species" they

could remain subspecies indefinitely or, if more mature consideration showed them to be defensible as species, they could later be elevated to that rank with perfect propriety. I suppose that every myrmecologist has resorted to this method at times but one should look for better reasons than this before putting much stress on specific incipience as a basis for elevating subspecies. In this connection I would like to call attention to the fact that, although the subspecies has been in use as a rank in ant taxonomy for more than forty years the merest handful of forms have been raised from this rank to specific status. It may be argued that the time was not ripe for such taxonomic translation but this is not, in my opinion, the real reason. For all his conservatism the myrmecologist has never been loath to describe new species when these are sharply defined. We may grant that a considerable personal factor can enter here. This in no way weakens the argument. Whatever the personal equation governing specific delimitation may be, the description of a subspecies is proof that it shows a closer relationship to some other form than the describer would permit in the case of a species. Unless I am sadly mistaken by the time that this sort of incipience blossoms into full specific status there may be no myrmecologists to record the fact. Nor do I believe, even if we take the subjective viewpoint, that the elevation of the subspecies will give permanent nomenclatorial relief. If we accord specific status to the subspecies this automatically creates a superspecies. Let me illustrate what I mean. There are nine described subspecies in the case of *Formica rufa* L. The differences by which they may be separated are small variations of proportion, pilosity and color. Suppose that we kick all nine of these subspecies upstairs and make each a species. What shall we then call *F. foreliana, ciliata, dakotensis* and the other species which are now included in the "*rufa* group"? The relationship of each one to *rufa,* as long as *rufa* is a complex, is logical and satisfactory. Their cospecific status with the elevated subspecies of *rufa* would be quite another matter. With the "group" already enjoying a sub-rosa existence in formicid classification cán anyone doubt that it will soon develop into another taxonomic rank if we elevate the subspecies?

Of recent years I have ceased to worry about subspecies as incipient species because of the greater interest which attaches to them as geographical races or choromorphs. In this I claim no originality for the idea has been repeatedly advanced by myrmecologists. Indeed one may point out that when Forel set about using the infra-specific unit for the first time it was as a geographical race. We cannot too much regret that the clarity of Forel's original stand, based as it was on intensive field work, should have been stultified by his subsequent acceptance of Emery's two subspecific ranks. Once Forel became enmeshed in this system his earlier views concerning the choromorph suffered considerable damage. It seems certain that no small part of this was due to his increasing preoccupation with cabinet specimens whose exotic sources prevented field analysis. Adequate studies of this sort have been rare in myrmecology. This may surprise those who rightly regard the myrmecologist as an active field worker. There is a world of difference between taking specimens in the field and zoögeographical analysis. The first requires mainly patience, the second demands a working knowledge of previously described variants plus a highly organized survey type of collecting which must cover hundreds or thousands of miles in the field. It is not surprising that the results of the two methods differ. A beautiful example of this is to be found in W. M. Wheeler's two papers on the Australian genus *Leptomyrmex*. The first of these, published in 1915, was based largely on cabinet specimens. Wheeler had, it is true, collected a few forms in Queensland and New South Wales but the records based upon preserved material from other sources outnumbered these six to one. In this first paper Wheeler described a number of new varieties several of which were known from a single small nest series and one or two from unique specimens. As to what these varieties represented Wheeler made no attempt to state. His second publication on *Leptomyrmex* appeared in 1934. In 1931–2 he had spent considerable time in Australia and had made a much more extensive first-hand acquaintance with these insects. In this paper his personal field records constitute a third of the total. Moreover he had the advantage of his previous knowledge of the group. It is, therefore, not surprising that the introduction of the second paper carries the following remarks:

"At the present time 14 species are known. Several of them exhibit well marked color forms which Emery, Forel and I regarded as 'varieties.' Their constancy and local distribution, however, have convinced me that we are really dealing with distinct races or 'Formenkreise.' I have therefore raised all these varieties to subspecific rank."

I am convinced that this concept will apply to most if not all of the valid infra-specific variants. I believe that adequate field studies on such complexes will show that their constituents, whether subspecies or varieties, are choromorphs. I am certain that this is true in the case of a number of infra-specific complexes in the genera *Formica, Pogonomyrmex* and *Aphaenogaster*. It seems to me that this suggests a very sound treatment for nomenclatorial simplification. If most subspecies and varieties are choromorphs why need we longer attempt to distinguish between the two ranks? Such a separation has always rested on an auctorial basis which cannot be subjected to analytical evaluation. The merging of the two ranks does away with this difficulty and promotes the concept of the infra-specific unit as a zoögeographical entity. As such its status can be tested by field observation. The nomenclatorial gain is too obvious to require comment; the most troublesome term of all is thereby relegated to limbo. In addition the present specific *status quo* is preserved in such a manner that no need for additional ranks should be felt. In opposition the worst that can be said is that the change gives too much prominence to a number of variants of doubtful validity. This is a fault of the describers and not of the suggested change.

I propose, therefore, that myrmecologists continue to exercise the conservatism for which they are famous and give over a taxonomic practice based largely upon auctorial evaluation for one more susceptible to factual proof. Let us reduce all infra-specific variants to a single rank, the subspecies, and thereafter eschew all temptation to return to varietal description. Most important of all let us refrain from describing additional infra-specific variants unless these have first been validated by adequate field observation.

BOOK NOTICE

How to Know the Insects. By H. E. Jaques, professor of Biology, Iowa Wesleyan College. 12 m., 140 pp., 254 illus. Iowa Academy of Science, Biol. Bull. no. 1. Chicago. John S. Swift Co., 1937. paper $1.00. cloth $1.80. (Planographed.)

An illustrated key to the more common families of insects, with suggestions for collecting, mounting and studying them, this publication has been designed to make it easier to acquire a ready knowledge of the various kinds of insects. While it has been written with special reference to the insects of Iowa, it should be applicable throughout the Middle West and of real practical helpfulness wherever insects are being studied. Not only are illustrated keys provided for the identifications of the orders and of the principal families, but one common representative of each included family is pictured and briefly described. In all, 195 species of common insects are thus treated. This feature alone makes the work of much value to students particularly beginners in entomology and those in elementary status. Reference also has been made to many keys and descriptions by other authors. Many of the illustrations are original; others have been gathered from various sources by permission, recognition for which is indicated. A large number of these drawings have been made by the author's students from specimens in the Iowa Survey collections. Publication and distribution of this valuable little book has been made possible by the technical and financial support of the Iowa Academy of Science. Its use for the purpose for which it has been prepared is very heartily recommended.—J. S. W.

SYNOPSIS OF NORTH AND CENTRAL AMERICAN HOLCOCEPHALA WITH A DESCRIPTION OF A NEW SPECIES (DIPTERA: ASILIDÆ)

By A. Earl Pritchard
University of Minnesota

The genus *Discocephala* was erected by Macquart (1838) to include *rufithorax* Wiedemann (Brazil) previously ascribed to *Dasypogon, oculata* Fabricius (S. Amer.) previously ascribed to *Dioctria,* and a further species *rufiventris* Macquart (Eastern U. S.) which is a synonym of *abdominalis* Say described under *Dasypogon. Discocephala,* preoccupied by Laporte-Castelnau in Hemiptera (1832), was renamed *Holcocephala* by Jaennicke (1867). Loew has misspelled the genus as *Helcocephala* and Williston as *Holocephala.* Hermann (1924) designated *rufithorax* as genotype and removed the African species and part of the South American species to the genus *Rhipidocephala.*

The genus *Holcocephala* is limited in distribution to the new world. A new genus is needed to take care of de Meijere's *hirtipes* (Java) described under *Holcocephala* and will probably include *hirsuta* van der Wulp (Sumatra) described under *Discocephala* and closely related to *hirtipes.* De Meijere's *hirtipes* is related to *Holcocephala* but differs by having a small spine at the tip of the third antennal segment above the single segmented style, the bristle at the end of the style curved in a hook, the anal cell open, the body and legs very hairy, and by lacking the supra-oral groove. *Holcocephala* has a single segmented style with a straight distal bristle, a closed anal cell, a supra-oral groove, and is usually nearly bare. *Hirtipes* is more closely related to *Rhipidocephala* but differs in having the antennæ as described rather than with a two segmented style. It is more distantly related to *Damalina* and *Trigonomima* (Formosa, East Indies) which have a curved spine at the tip of the third antennal segment as well as a terminal arista, to *Damalis* (Asia, E. Indies, Afr., Amer.) and to the four related African genera that have been proposed which have only a terminal arista, lacking a style. Walker's three spe-

cies, *concolor* (Celebes), *dorsalis* (Moluccas, Borneo), and *prytanis* (Bengal), which he referred to *Discocephala,* may belong to *Damalis* or *Damalina.*

These genera, *Holcocephala, Rhipidocephala,* the genus left unnamed, *Damalina, Trigonomima, Damalis, Lasiodamalis, Lophurodamalis, Icariomima,* and *Discodamalis* form a homogeneous group of the subfamily *Dasypogoninæ* which is characterized by having an open marginal cell, a prosternal plate directly contiguous with the pronotum, an absence of acanthophorites and spines in the female ovipositor, seven normally visible abdominal segments in the male, and by having the head over twice as wide as high with a ''goggle-eye'' appearance. This group of genera is closely related to Hermann's tribe *Prytanini* which differs by having the male abdomen reduced to six visible segments in the male, and by having the eyes normal, about one and one-half times as broad as high. The genera may be further subdivided into groups on the basis of the structure of the metasternum and the presence or absence of an antennal style or arista. The former will probably be more valuable in this connection than the latter. *Holocephala* has the metasternum broken down, leaving the median part that is in junction with the abdominal sternum unsclerotized; *Damalis* has the metasternum extending as a sclerotized plate behind the posterior coxae.

In the United States the species of *Holcocephala* are rather well known, but the Mexican species have been largely unrecognized since described by early workers. As a result of the collecting of Dr. R. H. Painter in Honduras and of the author in southern Mexico, a considerable amount of material has been accumulated. New synonymy, the occurrence of South American species in Central America, and one new species are included in this paper. For the sake of completeness, diagnostic descriptions of all the North and Central American species are given and a key is included to facilitate their determination. Specimens from which descriptions are here drawn are designated as plesiotypes.

Holcocephala Jaennicke

1838. *Discocephala* Macquart, Dipt. Exot., i: 166 (preocc.).
1867. *Holcocephala* Jaennicke, Neue Exot. Dipt.: 51.

1874. *Helcocephala* Loew. Berl. Ent. Zeitschr., xviii: 377.
1891. *Holocephala* Williston, Trans. Ent. Soc. Amer., xviii: 72.
1924. *Holcocephala* Hermann, Verh. Zool.-Bot. Ges. Wien, lxxiv: 153.

Hermann (1924) has presented a partial key to the *Holcocephala* which will be a valuable aid for identification of South American forms.

Enderlein has proposed the genus *Arthriticopus* for *nodosipes* Enderlein (Columbia) on the basis of abnormally enlarged posterior metatarsi and distal part of posterior tibiæ. Further study will quite likely show this species to be a synonym of *Holcocephala scopifer* Schiner (Venezuela, Peru) which Hermann did not consider worthy of generic rank.

Key to North and Central American Species

1. Posterior femora with several large, elongate tubercles below (Venezuela, southern Mexico) .... *spinipes* Hermann
   Posterior femora without tubercles 2
2. Abdomen strongly coarctate on proximal part 3
   Abdomen not coarctate 4
3. Thoracic pleura light gray pollinose (eastern U. S.) .... *calva* (Loew)
   Thoracic pleura dark brown pollinose (southern Mexico) .... *stylata* n. sp.
4. Face with a dark, inverted "V" shaped marking 5
   Face without such a marking 6
5. Abdomen wholly brown pollinose; the three dark mesonotal vittæ united anteriorly (South America to southern Mexico) .... *oculata* (Wiedemann)
   Abdomen with ochreous fasciæ on proximal segments; mesonotal vittæ separated (southern Mexico, Venezuela) .... *nitida* (Wiedemann)
6. Wings with a hyaline band on distal half 7
   Wings entirely fuscous, sometimes lighter on distal half 8
7. Mystax brown; abdomen unicolored, black pollinose (Mexico). *affinis* (Bellardi)
   Mystax yellowish; abdomen dark brown pollinose with lateral margin considerably lighter (southern Mexico) .... *divisa* (Walker)
8. Mesonotum conspicuously clothed with brown hairs; brown species with brown legs (Texas) .... *bullata* Bromley
   Mesonotum practically bare; legs blackish or yellowish 9
9. Legs largely yellowish; wings paler distally (eastern U. S.). *abdominalis* (Say)
   Legs largely black; wings darker on costal margin, not paler distally (southern Mexico) .... *deltoidea* (Bellardi)

Holcocephala spinipes Hermann

1924. *Holcocephala spinipes* Hermann, Verh. Zool.-Bot. Ges. Wien, lxxiv: 165.

Black; head brown pollinose anteriorly, cinereous posteriorly; mystax an oral row of brown bristles and brown hairs thinly on lower half of face; two ocellars, bristles on proximal two antennal segments, and palpal hairs, brown; antennal style about one-fifth the length of third segment. Thorax cinereous pollinose, the mesonotum mostly brown; three wide mesonotal vittæ dark brown and hardly differentiated; mesonotum and scutellum with white hairs except on vittæ; pleura white haired. Legs castaneous; vestiture whitish or pale yellowish, on tarsi and tips of tibiæ, brown; hind femora on distal half below with two or three strong, elongate tubercles. Wings lightly fuscous, very long and slender. Abdomen dorsally brown pollinose, cinereous on posterior two-thirds of lateral margin of each segment and on anterior third of second segment; venter grayish pollinose; lateral margins white pilose, longer on proximal segments. Length, 6.5 to 8 mm.

Type material.—One male, two females from Venezuela in the collection of the Natural History Museum in Wien.

Plesiotype.—Male, Jalapa, Vera Cruz, Mexico, July 8, 1935 (A. E. Pritchard), in collection of the University of Minnesota.

Additional specimens examined.—Three males, seven females, Jalapa, Mexico.

Holcocephala stylata new species

Black, with dark brown and luteous pollen; legs brown; wings fumose. Especially characterized by the strongly developed antennal style, the strongly spatulate abdomen, and the occurrence of r-m beyond the middle of cell 1st M_2. Length, 8 mm.

Female.—Head white pollinose, with brown pollen on vertex, oral margin, face around antennal bases, and weakly in two diverging lines, one from each antennal base to lower, lateral margin of face; bristles on palpi and proboscis yellowish; mystax composed of fine white hairs over lower half of face, thicker on oral margin; antennæ black, the three segments brown pollinose; first pale haired below; second black haired above and below; third gradually incrassate with several microchætæ above near tip; style shining, tapering, three-fourths as long as third segment and bearing a small distal bristle.

Thorax brown pollinose, with cinereous pollen present as a spot above each wing articulation continued mesad in a line along transverse suture, a small spot above each posterior callus, broad margin of scutellum, and on either side of metanotum; mesonotum and scutellum thinly clothed with fine white hairs; pleura thinly white pilose.

Legs castaneous, the posterior femora below and posterior tibiæ except incrassate apex, a little paler; vestiture mostly white and yellowish, the

bristles of anterior four tarsi and sometimes part of those of hind tarsi, black.

Wings long and slender, evenly fumose; crose vein r-m a little beyond middle of cell 1st M_2.

Abdomen with second and part of third segments strongly constricted, beyond this widened and flattened; tergum one with pollen on proximal division brown, on distal division luteous, the lateral margin and venter with long white hairs; second luteous with a large brown spot covering most of proximal third, and continued posteriorly in a narrow dorsal line that falls short of the caudal margin, the lateral margin and venter white pilose; third brown with a large luteous triangle on either side, their apices directed inwardly and nearly meeting on middorsal line; fourth brown except narrow caudal margin, luteous; sternites one to four cinereous, five to seven brown.

Holotype.—Female, Oaxaca, Oaxaca, Mexico, July 12, 1935 (A. E. Pritchard) in collection of the University of Minnesota.

Paratypes.—One specimen, Oaxaca, Oaxaca, Mexico, July 12, 1935 (A. E. Pritchard).

H. stylata is related to *calva,* differing mainly in the large antennal style, the thickly white haired oral margin, the brown pollinose thoracic pleura, and the luteous pollinose maculations of the abdomen. This species was found on tips of dead oak branches on a very dry hillside near Oaxaca in the arid western part of Mexico, while the other Mexican species were taken on the verdant and humid Gulf slopes on the eastern side of the Republic.

Holcocephala calva (Loew)

1872. *Discocephala calva* Loew, Cent., x: 35.
1909. *Holcocephala calva* Back, Trans. Amer. Ent. Soc., xxxv: 309.

Black; head brown pollinose in front, cinereous behind; mystax a few pale yellowish oral bristles and a few fine, white hairs on lower half of face; antennæ brown pollinose, the proximal two segments with brown bristles; style shining black, about one-third as long as third segment. Thorax cinereous pollinose, otherwise practically bare. Legs castaneous, the vestiture pale, on the tarsi and tips of tibiæ light brownish. Wings long and slender, evenly brownish; cross vein r-m just before middle of cell 1st M_2. Abdomen coarctate, the second segment constricted, longer than broad; tergum brown pollinose, the incisures and lateral margins of proximal segments grayish pollinose; sternum cinereous pollinose. Length, 7 to 9 mm.

Type.—Female from Texas in the Museum of Comparative Zoology.

Plesiotype.—Male, Hugo, Oklahoma, June 20, 1934 (A. E. Pritchard).

Additional material examined.—Numerous specimens from eastern Okla., Tenn., Miss., and Kans.

A common species, often found in company with *abdominalis* in forested areas. Occurs from New Jersey to Florida west to Texas and Kansas.

Holcocephala nitida (Wiedemann)

1830. *Dasypogon nitida* Wiedemann, Aussereur. Zweifl. Ins., ii: 643.
?1860. *Discocephala interlineata* Walker, Trans. Ent. Soc. London, n. ser., v: 279 (new synonymy).
1861. *Discocephala nitida* Bellardi, Saggio di Ditterol. Messic., ii: 84.
1901. *Holcocephala nitida* Williston, Biol. Centr.-Amer., Dipt., i: 308.

Black; head ochreous pollinose anteriorly, the face with two diverging lines of brown pollen, one from each antenna to the lower lateral side of the face; head cinereous pollinose posteriorly except broadly ochreous around occiput; oral bristles and bristles of palpi yellowish; antennæ with small bristles on proximal two segments brown; style one-fourth the length of third segment. Mesonotum bright ochreous pollinose with three separate vittæ (anterior brown suffusion, when present, not uniting them); lateral mesonotal vittæ falling well short of anterior and posterior calli; dorsum sparsely clothed with minute, yellow hairs; pleura with the few hairs present, yellowish. Legs dark brown, the trochanters and femora proximally light brown; vestiture pale yellowish. Wings wide proximally, fumose, darker on costal side of basal half; cross vein r-m just before middle of cell 1st M_2. Abdomen brown pollinose; ochreous on segment one, on two except on proximal third, and very broadly on sides of three; cinereous on sides of four to seven. Length, 5 to 9 mm., usually 7 or 8.

Type material.—*Nitida* was described from specimens from Mexico in the Berlin museum; *interlineata* was described from female from Mexico in the British museum.

Plesiotype.—Male, Jalapa, Vera Cruz, Mexico, July 8, 1935 (A. E. Pritchard).

Sixty-one additional specimens from Jalapa, Mexico, maintain the constancy of this characterization. Hermann mentions similar specimens from Venezuela in his discussion of *oculata*. *H. interlineata* (Walker) is very likely the same species; the interlineation of the middorsal mesonotal stripe with yellowish is a variable and unimportant character. *H. minuta* (Bellardi) is not recognized here as a synonym of this species as Williston considered it.

Holcocephala oculata (Fabricius)

1805. *Dioctria oculata* Fabricius, Syst. Antliat.: 151.
1821. *Dasypogon oculatus* Wiedemann, Dipt. Exot.: 230.
1838. *Discocephala oculata* Macquart, Dipt. Exot., i: 166.
1849. *Dasypogon agalla* Walker, List Dipt. Brit. Mus., ii: 361.
?1861. *Discocephala minuta* Bellardi, Saggio di Ditterol. Messic., ii: 83 (new synonymy).
1924. *Holcocephala oculata* Hermann, Verh. Zool.-Bot. Ges. Wien, lxxiv: 161.

Differs from *nitida* in having the abdomen dorsally brown pollinose with narrow lateral margin cinereous, the mesonotal vittæ broadly united anteriorly with the lateral mesonotal vittæ continued posteriorly to the scutellum, and in averaging smaller in size. The genitalia of the species are the same, but a series maintaining the constancy of characters stated does not call for making *nitida* a synonym of *oculata* at the present time.

Type material.—Of *oculata* from South America in the museum at Copenhagen; of *agalla* from Venezuela in the British Museum; of *minuta* from Tuxpango, Mexico, in the zoological museum at Torino.

Hermann recognized the typical *oculata* from Brazil, Peru, Bolivia, and Venezuela. Specimens from Puerto Castilla, Honduras (R. H. Painter), are indistinguishable from material from Brazil. Specimens at hand from Peru differ in having the palpi black haired. *H. minuta* (Bellardi) (Southern Mexico) is here considered a synonym of *oculata;* Bellardi separated this species from *nitida* by the more extensive, black mesonotal vittæ and smaller size. Hermann reduced *urruguayensis* Arribalzaga to a

variety of *oculata* and described another variety at the same time. It is possible that both of these are worthy of specific rank.

Holcocephala divisa (Walker)

1860. *Discocephala divisa* Walker, Trans. Ent. Soc. London, n. ser., v: 279.

1861. *Discocephala longipennis* Bellardi, Saggio di Ditterol. Messic., ii: 86.

Black; head brown pollinose anteriorly, cinereous posteriorly; mystax a few yellowish hairs on lower half of face and a row of yellowish oral bristles; palpi with yellow bristles; antennæ with style one-third the length of third segment. Mesonotum mostly brown pollinose with three very wide, dark brown vittæ; pleura below with pollen tending towards cinereous, thoracic dorsum noticeably clothed with fine white hairs, pleura rather thickly so. Legs castaneous; vestiture brownish, the thick, appressed hairs on inside of anterior tibiæ and tarsi, white. Wings wide proximally, dark fumose with a wide, hyaline band on distal half leaving the wing tip fumose to a variable extent or hyaline. Abdomen with dorsum dark brown pollinose, the wide lateral margin somewhat paler; venter light brown pollinose. Length, 7 to 9 mm.

Type material.—*Divisa* was described from a female from Mexico in the British Museum; *longipennis* was described from specimens from Mexico in the zoological museum at Torino.

Plesiotype.—Male, Jalapa, Vera Cruz, Mexico, July 8, 1935 (A. E. Pritchard).

Additional specimens examined.—Six males and eleven females from Jalapa, Mexico.

Hermann has suggested the synonymy of *divisa* and *longipennis* and this has been followed here. *H. divisa,* however, has priority as used by Kertesz in his Catalogue of Asilidæ. This species is known only from Mexico.

Holcocephala affinis (Bellardi)

1861. *Discocephala affinis* Bellardi, Saggio di Ditterol. Messic., ii: 86.

Bellardi describes *affinis* stating that it differs from *longipennis* in that the proportional length of the body in somewhat less; the

mystax is brown; the thorax is almost entirely black; the abdomen is not lighter on the sides; the wings are shorter, their posterior margin almost straight, and their markings more intensely black. This species has not been recognized again.

Type material from Mexico in the collection of the Zoolog. Mus. of Paris and in the Zool. Museum at Torino.

Holcocephala bullata Bromley

1934. *Holcocephala bullata* Bromley, Ann. Ent. Soc. Amer., xxvii: 89.

"Male.—Head black, face dark gray pollinose, vestiture pale golden brown, antennal style spine-like, pointed at tip, directed forward and slightly downward, and about three-fourths the length of the third segment. Thorax dark brown pollinose, scutellum slightly lighter. Halteres pale brown. Wings brown, basal half opaque. Legs and abdomen brown, vestiture pale golden brown. Genital forceps from above slender, widely separate.

"Female.—Similar, ovipositor with pale hairs."

Holotype.—Male, Bexar Co., Texas, in collection of Texas Agric. Exp. Station.

Known only from type material from Texas.

Holcocephala deltoidea (Bellardi)

1861. *Discocephala deltoidea* Bellardi, Saggio di Ditterol. Messic., ii: 85.

Black; head pale yellowish gray pollinose anteriorly, sometimes with a greenish tinge, brown on ocellar tubercle and on sides of vertex, and cinereous posteriorly; mystax a thin row of yellowish bristles and several small, yellowish hairs above; hairs on palpi and below on proximal two antennal segments yellowish; antennal style one-fourth the length of third segment. Thorax dull ochreous pollinose, sometimes with a few white hairs posteriorly and on scutellum; pleura with hairs white. Legs black, the tibiæ proximally and sometimes femora proximally, narrowly dark reddish; vestiture pale yellowish, the tarsal bristles partly brown. Wings long and slender, fumose, darker along the costa. Abdomen dorsally brown pollinose, usually dull ochreous on caudal

half of segment one, on median third of two, base of three, and sides of proximal segments; venter light ochreous; a few whitish hairs on sides and venter of proximal segments.

Type material from Mexico in the collection of the Zool. Mus. of Paris and in the Zool. Mus. at Torino; not again recognized until now.

Plesiotype.—Male, Jalapa, Vera Cruz, Mexico, July 8, 1935 (A. E. Pritchard).

Additional specimens examined.—Three females, Jalapa, Mexico.

Holcocephala abdominalis (Say)

1823. *Dasypogon abdominalis* Say, Jour. Acad. Nat. Sci. Philad., iii: 50.
1838. *Discocephala rufiventris* Macquart, Dipt. Exot., i: 166.
1849. *Dasypogon œta* Walker, List Dipt. Brit. Mus., ii: 360.
1867. *Dasypogon laticeps* v. d. Wulp, Tijd. v. Entom., x: 137.
1909. *Holcocephala abdominalis* Back, Trans. Amer. Ent. Soc., xxxv: 309.

Black; head brownish ochreous anteriorly, brown on ocellar tubercle and vertex or sides of vertex, and cinereous posteriorly; palpal and oral bristles yellowish; antennal style one-fourth as long as third antennal segment. Thorax ochreous pollinose above, cinereous on sides below; mesonotum with three brown vittæ, the median one anteriorly reaching pronotum, the lateral ones caudally falling short of posterior calli and sometimes very small; mesonotum with a few very short, brown setæ on vittæ, and a few small white hairs posteriorly and on scutellum; pleura with hairs white. Legs yellowish, brownish on tips of tibiæ and tarsal segments; vestiture yellowish. Wings rather wide proximally, fumose, the distal half or less paler to a variable extent. Length, 4.5 to 7 mm.

Types.—Say's type is lost; *œta* was described from specimens from Florida and Massachusetts in the British Museum; *rufiventris* was described from material of both sexes from Carolina and is probably at Lille; *laticeps* was described from a male from North America and is in the museum at Leiden.

Neotype.—Male, Hugo, Oklahoma, June 20, 1934 (A. E. Pritchard).

Numerous other specimens examined from Okla., Ga., Maryl., N. C., Kans., Va., Kans., N. Y., N. J., Tenn. Back records the species from New Hampshire to Florida west to Texas and Nebraska. In Oklahoma, *abdominalis* is found only along the eastern side of the state. There are, however, specimens in the collection at the University of Kansas from New Mexico and from Alberta, Canada, which are larger, but indistinguishable, and have identical male genitalia.

RELOCATION OF THE TYPE LOCALITY OF POROSAGROTIS ORTHOGONIA MORR.

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This species of noctuid moth was first described by H. K. Morrison,[1] in 1876, from Glencoe, Nebraska. The moth was one sent to him by Gen. G. M. Dodge, one of the construction engineers of the Union Pacific Railroad. For over fifty years this place has not been printed on the Nebraska maps and students of the Noctuidæ have had difficulty in locating it. The old maps show it to be a small village, situated on Pebble Creek, in the northwestern part of Dodge County. Its site is six miles south of the town of Dodge and nine miles west of Scribner. This is over three hundred miles east of the nearest known infestation of the larvæ, since they were reported from Chadron, Nebraska, last summer.

[1] Descriptions of New North American Noctuidæ. Proc. Bost. Soc. Nat. Hist. XVIII, 1876, p. 239.

BIONOMIC NOTES ON EXARTEMA FERRIFERANUM WALK. (LEPID., OLETHREUTIDÆ) AND ITS PARASITES (HYM: BRAC., CHALC.)*

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The genus *Exartema* is a group of Tortricoid moths which has interfered but little with the cultivation of economic plants in North America. Slingerland and Crosby (14) gave brief accounts of *E. malanum* Fernald, the apple budworm, and *E. permundanum* Clem., the raspberry leaf-roller. The food plants of several other members of the genus are cited by Kearfott (07) and Heinrich (23). *E. ferriferanum* Walker was described in 1863 from Virginia and subsequently renamed by Clemens and Zeller (Dyar, 02), but nothing seems to have been recorded concerning its bionomics. The writer submits observations on approximately twenty individuals of *ferriferanum* found on *Hydrangea* in and near Urbana, Illinois, in May and June of 1936.

Attention was attracted to it by the conspicuous cases formed by the larva from the succulent and still immature terminal leaves. The majority of these leaf-cases occurred on the cultivated species, *Hydrangea arborescens grandiflora,* a few on the wild form, *H. arborescens* growing in the writer's garden, and one dried case was taken on a wild plant in nature early in September. In most instances the cases were composed of a pair of opposite leaves whose upper surfaces were brought face to face, but united by larval silk only along the margins which were precisely coextensive, while the discal areas of the two blades bulged out roundly. In several instances the case consisted of but a single leaf, the leaf blade then being doubled symmetrically upon itself along the mid-

* Contribution Number 185 from the entomological laboratories of the University of Illinois.

The writer gratefully acknowledges the services of Messrs. A. B. Gahan, Carl Heinrich and C. F. W. Muesebeck, all of the U. S. National Museum, in determining the insects, and of Mr. James Hutchinson, University of Illinois, who identified the plants, concerned in this paper.

rib, and the margins of the leaf held together neatly with silk. The leaf-cases of *E. ferriferanum* therefore assume two distinct shapes, but are alike in possessing an inflated appearance. Only a relatively small part of the lumen of the case is utilized by the inhabiting insect. In the center of the interior, the larva constructs a rather light cocoon which appears to consist of bits of excreta or vegetable substance united and lined inside with silk. In this cocoon within the leaf-case the larva transforms to the adult state.

When discovered on May 31, this insect had largely completed its larval life. One larva had begun to shorten and thicken in preparation for pupation, and all others had already become chrysalises or ceased development owing to parasitism. During the period of June 2 to 10, ten moths issued from their leaf-cases, invariably leaving the empty chrysalises sticking cephalic end outward through a circular hole in the leaf. The hole was, in all probability, cut by the mature larva and always occurred at a point near the head end of the cocoon with which the aperture seemed to be joined by a short silken runway. Since the leaves involved in the construction of the leaf cases bore no noticeable evidence of larval feeding, it is possible that the cases are built exclusively to shelter the insect during its pupal period. Failure to find such leaf-cases again during July, August and September suggests that *E. ferriferanum* undergoes only one generation per year in central Illinois and may spend most of the summer as well as the winter in the adult or egg stage, if, indeed, it has no alternate food plants.

The following brief descriptions of the three stages observed may serve to distinguish this species from similar species that may frequent *Hydrangea.*

Adult.—Very similar to the codling moth in size and shape of the wings; hind pair plain, moderately smoky above, dull silvery below; front pair largely smoky black beneath, the upper surface with a basal rusty brown patch and another of the same color but roughly spindle-shaped extending obliquely across the outer-anterior quarter, rest of surface whitish-yellow and irregularly speckled rusty brown.

Mature larva.—Length 15 mm., body medium green with head

and pronotal shield dark brown, thoracic legs and mouth parts more or less chitin-brown; surface microscopically and densely setose, and very sparsely hairy; crochets of first four pairs of prolegs forming a complete circlet, those of anal pair horse-shoe like in pattern, open behind.

Chrysalis.—Length 9–11 mm. (2 specimens); pale to deep brown, shiny; surface densely and microscopically setose; cremaster of eight feebly curved hooks; subapical longitudinal slit on venter of last abdominal segment; seven pairs of abdominal spiracles, pairs 3 to 7 situated beyond tips of wing cases; each spiracle-bearing segment provided dorsally with two transverse rows of short pointed stout creeping spurs none of which extend beyond spiracles laterally; the number of spurs per row per segment is given in the accompanying table, the numbers in the squares referring to the first and the second specimens, respectively:

Segment Number	1	2	3	4	5	6	7
First Row	7,8	13,12	18,17	15,17	16,18	14,15	13,9
Second Row	21,23	28,30	21,33	23,31	21,28	10,13	11,7

Two species of Hymenoptera were reared from the material of *Exartema* described above. One male of the Braconid, *Microgaster epagoges* Gahan issued on June 6, 1936, from a plain white elongate-oval cocoon measuring 5.5 mm. long and found within the rather flimsy cocoon of *E. ferriferanum* in the usual leaf-case. No trace of the host's chrysalis was present. Accordingly, the larva was the host stage parasitized, which, however, succeeded in maturing and constructing its cocoon for pupation but was overcome by the *Microgaster* before changing to the pupal state. Gahan (17) described *M. epagoges* from specimens reared by C. C. Hill from the larvae of the Tortricid, *Epagoge sulfureana* Clem., in Tennessee, and Knull (32) bred it as a parasite of the larvae of *Tortrix argyrospila* Walk.

Three other larvæ of *ferriferanum* were killed by what doubtlessly were *M. epagoges;* the cocoons of each of these caterpillars contained a white cocoon similar in every way to that above from which the male *epagoges* issued. However, these cocoons were in turn parasitized by the Eulophid Chalcid, *Dimmockia pallipes*

(Mues.). Thirty-four *pallipes* came from the three cocoons; dissection of one produced the pupal exuviæ of no less than ten individuals. Muesebeck (27) described *D. pallipes* from specimens hyperparasitic on another Braconid, *Apanteles melanoscelus* (Ratz.), an imported parasite of the gipsy moth. Records available in the Review of Applied Entomology, Ser. A, 1913–1934, show that also other species of *Dimmockia* have been reared as secondary parasites.

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BIOLOGY OF THE NEW CHALCID PARASITE CIRROSPILUS INIMICUS GAHAN

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While making a study of hymenopterous parasites associated with *Samia cecropia* Linnæus in the Chicago area (Marsh '34), the writer found a black-and-yellow chalcid which A. B. Gahan determined as a new species of *Cirrospilus* Westwood. Upon request Mr. Gahan has kindly described this species (Gahan '34) and assigned to it the name *C. inimicus.* Opportunity is here taken to present some life-history details which were discovered during further study of this new species.

In the Chicago area this chalcid was found to be a secondary parasite of the ichneumonid *Spilocryptus extermatis* Cresson which served as the principal primary parasite of Cecropia in that region. *S. extrematis* is present in the field in the larval form throughout the year and *C. inimicus* is an active parasite of it whenever temperature conditions will permit. Adults of the latter may emerge as early as the last of April. A cycle is completed every eighteen to twenty-one days and the number of these cycles is determined by the duration of warm weather. At least three cycles are completed each summer. Males average 1.4 mm. in length, females 2.1 mm.

Upon emergence the adults of *C. inimicus* find themselves imprisoned within the host cocoon which, with numerous others, lies within the cecropian cocoon. They gnaw through the thin host cocoon. Escape from the cecropian cocoon occurs via the valve or holes made by those of their host which escaped parasitization, or through openings made by woodpeckers or mice.

Copulation occurs upon infected cecropian cocoons often within the first hour after emergence. The males are very ardent. Precopulatory behavior always consists of the male mounting the thorax of the female and engaging in a vigorous shadow-boxing performance with his head and antennæ. The antennæ are curved rigidly downward and the tips brushed across those of the

female or occasionally touching her lightly in the face. This hammering action, achieved mostly by the motion of the long neck, goes on rapidly for from ten to twenty-five times, then a rest of about a second, then a repetition of the motions. He appears in a state of intense excitement evidenced by the stiffening of the posterior pair of legs. Following the second or third series of boxing he backs, curves the tip of his abdomen under one side of the abdomen of the female and copulates at the base of the ovipositor for a brief ten seconds. Following this he usually remounts and repeats the boxing a time or two then dismounts and hurries away. If a second male comes along during the mounting the first male will frequently quickly dismount and drive him away with a great show of violence in the form a beating with his antennæ. However, about as frequently, the first male is too busy with his boxing to see the second male approach from the rear. The latter usually copulates with the female while she is thus distracted. One male has been observed to alternate between two females with great activity. The normal life of the male is about four days while the female usually lives about seven days.

The inseminated female immediately reenters the cecropian cocoon and searches for her host larvæ by palpation of the ichneumon cocoons with her antennæ tips. She works very energetically and persistently at the egg laying. After a hasty examination of a cocoon containing a live larva or pupa of her host she quickly curves the end of her abdomen down, places the tip of the ovipositor, then vigorously thrusts it through the silk. Such force is used that the ovipositor plunges through and usually strikes the larva or pupa inside, which immediately begins to writhe and twist under repeated proddings. In one instance a female was seen to pierce from beneath, a cocoon containing a nearly mature pupa. For twenty-one minutes she clung to the cocoon vigorously jabbing the writhing pupa, the latter repeatedly bending the ovipositor aside by a spiral, twisting motion. The activity of the pupa gradually slowed until finally the ovipositor was driven through its cuticle and twisted about for a time inside the abdomen. Then withdrawing the ovipositor the chalcid placed five eggs on the surface of the pupa. The host larva or

pupa invariably dies within a few hours after being pierced. In spite of its vigorous egg-laying habits, *C. inimicus* is not prolific. The female seldom lays over one hundred eggs.

The eggs are club-shaped and quite smooth, measuring about 1.0×0.3 mm. Never more than eight were observed in any single cocoon of *S. extrematis*. Being only slightly adhesive when laid they may fall from the side of the host. In about forty-eight hours the larva suddenly breaks through the tough egg skin, punctures the host cuticle, and begins to drink the body fluids. It shifts constantly from one point to another over the surface until maturity is reached in about nine days. Larvae have been removed from the host, studied under a microscope and replaced at random repeatedly without any apparent disturbance in their development. Eggs laid by females which have not been inseminated always develop into males.

The pupa is quite flat, measuring 1.5–2.5 mm. in length. It differs from most chalcid pupæ in that it turns a glossy black in an hour or two after the larval skin flakes off. *C. inimicus* passes the winter in the host cocoon. It hibernates in the pupal form. Larvæ which are caught by cold weather invariably die.

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BOOK NOTICE

Source Book of Biological Terms. By Axel Leonard Melander, Department of Biology, The City College, The College of the City of New York, 1937. 8.5 × 5.5 in. VI + 157 p. $1.10.

This book, by all means, should be owned and consulted by everyone who has any curiosity at all about biological terms in current use. It is really a series of short adventures into the romance, sources, evolution, phylogeny and origin of words used in biology. And in addition, the author has written short chapters on uncertain and mistaken derivations, ancient customs and biological beliefs, unnatural history, accentuation, pronunciation, suffixes, prefixes, plurals, etc., all dealing with biological words and terms. And lastly, there is an "Alphabetical List of the Components of Biological Vocabulary."

Knowing the history and meaning of the scientific words one uses, affords added interest and pleasure to both amateur and professional biologists. For example, the name of the book louse *Troctes divinatorius* means literally, "an instinctive epicure." And the word toadstool is a Germanic term meaning "death sprout," and has nothing to do with a seat for toads. In addition, if this book had been available years ago, many of us would not have been taught so many mispronunciations by our professors, nor would such careless usage have become so fixed as to seem correct.

Professor Melander's book is both instructive and entertaining, and it gains by the latter quality because it is easy to remember something that is aptly and whimsically written. Even some of the page headings of the second portion have an amusing appeal—Brachy to Butter, Buzzard to Camel, Flagellum to Fox, Growth to Halibut, Serpent to Siphon, Vermis to Viper, etc.—H. B. W.

TARANTULA STUDIES*

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INTRODUCTION

The task of observing development, behavior, and other matters constituting the life history of tarantulas is a long time problem. and will require, owing to their longevity, probably not less than 25 years, and possibly 30 years. In view of this fact progress reports are perhaps justified. Preliminary biological studies and results of poison tests have previously been reported.

Taxonomic studies of tarantulas undertaken by various arachnologists, usually as a part of general spider taxonomy, are seemingly in a very unsatisfactory state. The difficulty lies mainly in a serious lack of constant and distinctive characters by which the various species may be recognized. These can in time be determined and they should be supported by extensive biological data. With this in view, I am attempting to follow the course of events in several tarantula colonies located on nearby hillsides and in addition I am maintaining, in the laboratory, a number of live tarantulas including all the species that can be secured. This paper pertains to development, regeneration, food and water requirements, and a method of extracting the poison. Unless otherwise stated, the species concerned is *Eurypelma californica* Ausserer.

DEVELOPMENT

Oviposition. This and cocoon-making are described in a previous publication. The number of eggs, based on the contents of 5 cocoons, varies from 631 to 1018 with an average of 812. Making the cocoon is an important event in which the construction of the cradle, preceding oviposition, requires about $9\frac{1}{2}$ hours. The entire process, as observed in one instance, consumes 15 hours and 15 minutes. The making of two additional cocoons was observed when the cradle was nearly complete. One of these and the one

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FIGURE 1. Tarantula under canopy.

mentioned above were in general like a hammock with one edge attached to the jar and the other raised so as to hold the egg mass. The third cocoon was begun by constructing, in addition to the hammock-like cradle, a semi-transparent canopy over it. This was about 4 inches in diameter and 3 inches high. The time consumed in the making of this and the previous cocoon was estimated at about 14 hours. Of eight cocoons constructed in the laboratory, three were constructed out of a hammock-like sheet; three included the making of a canopy over the sheet; and two were constructed in a cavity. In the latter cases the female apparently dug the cavity for this particular purpose. On completing the cavity it was at once lined with a dense covering of silk. The eggs after being deposited were, as in the other situations, covered with a dense sheet of silk. In making up the cocoon, the floor as well as the lining of the cavity, are taken up.

In the field cocoons are made, as observed in 4 cases, in two kinds of situations. (1) The hole is close to a rock lying at an angle but nearly on edge. At a depth of about 8 inches the hole has a pocket about 3″ by $3\frac{1}{2}$″; beyond it the hole continues for about 4 inches. In this pocket the cocoon is presumably constructed. Remnants of a lining and an empty cocoon are the only evidence. (2) The hole in the ground opens into some vacant space under a rock. Here this natural cavity at the entrance is utilized for cocoon making. Construction of the cocoon has not actually been observed here but circumstantial evidence as described above seems conclusive.

FIGURE 2. Canopy and sheet partly rolled up.

INCUBATION. The time spent in the cocoon, *i.e.*, the egg stage and the first instar combined, has until recently not been determined. Cocoons may be seen, in the field throughout the months of June, July, August, and early September. Observations on these cocoons, without knowing definitely the date of oviposition,

indicate that the young emerge from the cocoon in from 40–53 days. One cocoon opened on August 6 was found to contain what appeared to be newly hatched spiders. These emerged from the cocoon, which had been sewed up with needle and thread, 25 days later. A rough estimate is that the eggs hatch in 3 weeks and the spiderlings emerge 3 weeks later.

FIGURE 3. Cocoon practically finished, silken strand, for orientation, still remaining.

Out of a number of cocoons constructed in the laboratory and kept there under observation only two have so far produced young. Since cocoons in the field are brought into the entrance of the hole to be exposed to direct sunlight and possibly turned over to warm the eggs evenly, it has been assumed that failures to secure hatching in the laboratory result from unfavorable temperatures. In a few instances the contents of the cocoons have been destroyed by the females that produced them. This has happened 4 weeks after oviposition, when the eggs had presumably hatched.

Recently (1935) a cocoon having been made in the laboratory was put in a battery jar containing several inches of soil; this was placed in a south room, but protected by means of black paper against direct rays of the sun. Frequent wetting of the soil provided adequate humidity. Apparently outdoor conditions, though not matched, were approached within reasonable degree for the spiderlings emerged 47 days after oviposition.

Subsequently another cocoon constructed in the laboratory on June 27 (1936) and kept in a room on the north side of the building, thus without any direct sunlight, produced young on August 15, *i.e.,* in 49 days. It may be assumed that out of doors, under favorable conditions, the time spent in the cocoon is somewhat shorter. Both temperature and humidity probably play an important rôle. The excessively dry season of 1936 caused many of the eggs in the laboratory to shrivel up soon after oviposition.

The young spiders when emerging have either already gone through the first molt or they do so very soon afterward. Thereafter they presently scatter out on foot. If the cocoon is under a large stone dispersal may be delayed for two weeks; if the family emerges from an uncovered hole it may scatter in a week or in less time. This method of dispersal naturally results in local settlements of tarantulas and it tends to prevent the young from locating in an unfavorable habitat as they well might if they spread like many other spiders by ballooning as do even some near relatives of the tarantula such as the trapdoor spider, *Pachylomerus carabivorus,* and incidentally also the notorious black widow.

Infant mortality is high, 1–2-year-old tarantulas are very rarely seen. The few that survive live in small holes which for a large part of the year are closed.

Young tarantulas in the laboratory, if confined in considerable numbers, *i.e.,* an entire family (600–1000 young), will maintain themselves so far as food is concerned for nearly a year. Cannibalism has been observed about the middle of May when the spiderlings are about 8 months old. It increases rapidly so that by the middle of July the family may dwindle to 3 or 4 individuals. Termites are readily accepted and devoured; they may be used for food, provided once or twice a week, till the spiders

are about 3 years old. During the winter season (October to April) they require no food.

During the second year of their existence the young spiderlings molt 4 times, in May, June, July, and August. Some of them apparently molt but 3 times. The skins when mixed with the soil are easily overlooked. In the third year there may be 4 molts, or 3, or even 2. In the fourth and fifth year they shed twice under favorable conditions. Subsequently they have but one molt a year and they may go two years between molts.

Well supplied with food and water in the laboratory, the males may mature in about 8 years. Under out-of-door conditions, as stated in a previous publication, the required time has been estimated at 11 or 12 years. As pointed out elsewhere in this paper tarantulas can and probably do fast for considerable periods of time.

Definite and complete records on the time required for reaching maturity under laboratory conditions have finally been obtained. From a family that emerged late in July or early August, 1926, two individuals have been reared to maturity. One (A_2), a male, matured on August 23, 1936; another (A_4), a female, matured on August 25, 1936. Maturity in the male is, owing to the palpal organs, easily recognized. Maturity in the female has been proved by the fact that it mates readily. Development in these instances thus required 10 years and is the same for both sexes.

The following table of weights and measurements of a male is based largely on one individual.

Shrinkage in the length of the carapace, as indicated in this and the next table, is due to the somewhat crude method of measuring. A sharp-pointed caliper is used. One point is placed at the middle of the anterior margin; the other in the notch of the posterior margin.

Females apparently vary, like the males, in the time required for reaching maturity. Two individuals (WH_1 McI_5) taken in November, 1925, when they were about 4 years old (length 22.6 mm., carapace 9.0 mm.) have been in the laboratory for 11 years and are now at least 15 years old. WH_1 and McI_5 are mature females as proved by recent mating. How long they have been

MEASUREMENTS AND WEIGHTS OF A MALE TARANTULA (A_2) FROM HATCHING, ABOUT AUGUST 1, 1926, TILL MATURITY, AUGUST 23, 1936

Year	Age	Length of body in millimeters	Length of carapace in millimeters	Weight in grams
10/11/26	2½ mos.	*4.2	*1.5	*.0051
2/9/27	6 mos.	5.5	....	....
1/7/28	1 yr. 5 mos.	8.1	2.5	....
3/5/29	2 yrs. 7 mos.	14.5	4.8	.2407
10/7/29	3 yrs. 2 mos.	20.5	6.2	.8339
4/1/30	3 yrs. 8 mos.	20.5	6.8	.8045
10/17/30	4 yrs. 2½ mos.	....	....	2.6190
4/1/31	4 yrs. 8 mos.	....	....	2.4443
10/14/31	5 yrs. 2½ mos.	38.0	11.3	5.3955
4/13/32	5 yrs. 8½ mos.	37.8	11.8	5.4810
10/11/32	6 yrs. 2½ mos.	40.5	14.7	7.1107
4/14/33	6 yrs. 8½ mos.	42.6	14.2	7.3520
10/9/33	7 yrs. 2½ mos.	46.5	15.7	10.1100
4/18/34	7 yrs. 8½ mos.	45.5	16.0	9.7215
10/30/34	8 yrs. 3 mos.	47.1	17.1	10.9365
4/12/35	8 yrs. 8½ mos.	47.5	17.2	10.6616
11/6/35	9 yrs. 3 mos.	49.5	17.3	11.9282
4/18/36	9 yrs. 8½ mos.	48.0	16.8	11.4255
9/5/36	10 yrs. 1 mo.	47.7	18.6	11.8336

* Represents another individual.

Another male (WH_2) taken in 1925 when it was about 1 year and 3 months old (length 6.8 mm., carapace 2.3 mm.) matured in September, 1932, when it was about 8 years old. It lived till February, 1934, and thus attained an age of 9½ years.

mature is not known. A third individual (McI_6) taken at the same time as these above, but only 2 years old (length 10 mm., carapace 3.7 mm.), is now a mature female as proved by mating. It is at least 13 years old and has been in the laboratory for 11 years. The date of attaining maturity is not known.

MOLTING AND REGENERATION. Some observations on molting and regeneration have already been reported in earlier papers. When the male has reached maturity it has also gone through its last molt even though it may live as long as a year and 8 months (the maximum so far observed). The female, however, after becoming of age contiues to shed the skin approximately every year.

MEASUREMENTS AND WEIGHTS OF A FEMALE TARANTULA (A_4) FROM HATCHING, ABOUT AUGUST 1, 1926, TO MATURITY, AUGUST 25, 1936

Year	Age	Length of body in millimeters	Length of carapace in millimeters	Weight in grams
10/11/26	2½ mos.	*4.3	*1.6	*.0052
2/9/27	6 mos.	5.5	....	....
1/7/28	1 yr. 5 mos.	9.8	3.7	....
3/5/29	2 yrs. 7 mos.	16.4	5.6	.3386
10/7/29	3 yrs. 2 mos.	20.3	7.1	.8200
4/1/30	3 yrs. 8 mos.	21.1	6.9	.8668
10/17/30	4 yrs. 2½ mos.	....	....	2.8316
4/1/31	4 yrs. 8 mos.	....	....	2.6175
10/20/31	5 yrs. 2½ mos.	39.7	14.0	6.0550
4/13/32	5 yrs. 8½ mos.	38.5	14.0	5.7878
10/11/32	6 yrs. 2½ mos.	43.4	15.5	7.3144
4/14/33	6 yrs. 8½ mos.	42.7	15.5	7.8457
10/9/33	7 yrs. 2½ mos.	50.0	16.8	11.2522
4/18/34	7 yrs. 8½ mos.	47.6	16.8	10.6800
10/30/34	8 yrs. 3 mos.	48.4	18.5	11.3900
4/12/35	8 yrs. 8½ mos.	48.9	17.7	10.9556
11/6/35	9 yrs. 3 mos.	48.0	17.7	10.3416
4/18/36	9 yrs. 8½ mos.	47.5	18.0	10.5289
9/5/36	10 yrs. 1 mo.	49.0	18.6	11.7001

* Represents another individual.

The first symptom of an approaching molt is a refusal to feed. For 2–3 weeks no food is accepted. Then as a rule, the tarantula lays down a fairly thick silken sheet and just preceding the molt it may be observed lying ventral side up on the silken bed. Immediately before shedding begins the tarantula gets back on her feet. Now the carapace may be seen to rise in front and presently the anterior half separates all around and the tarantula rises till it gets top heavy and drops to one side. Thus lying, the wave-like movement of oozing out of the old skeleton continues till all the legs and the abdomen are out. The entire process requires about one hour.

Associated with molting appears the only sign of old age that tarantulas seem to exhibit. The old carapace fails to separate entirely from the new one. As a rule a slender portion at the

middle of the rear end remains attached; rarely the entire carapace adheres and is shed sometime (2 weeks in one case) later. In all cases, whether the tarantula succeeds in discarding the carapace, or whether it is removed with the aid of a scissors, there remains a small fragment at the junction of the abdomen. In all instances so far observed tarantulas exhibiting this fragment have lived approximately but one year longer. During the last year they are, however, quite normal even to the extent of mating if a male is provided at the proper time.

Females in retaining the juvenile character of molting also retain the capacity to regenerate lost appendages throughout life. If a leg is seriously damaged in the tibia, patella, or femur, the entire leg is discarded within one or two days and the severed appendage may be consumed if the tarantula has sufficient appetite.

A new leg is always appreciably shorter and thinner than the corresponding one on the other side. Its size depends largely on the time elapsing between the loss of the leg and the following molt. Observations on a number of cases of regeneration show that 53 days is sufficient time for growing a leg that is functional and with an about normal covering of hairs. If but 36 days intervene between the loss of a leg and molting, the new member is quite thin, pale, sparsely covered with hair, and scarcely used in walking. If the tarantula has but 20 days to grow a new leg, no visible attempt at regeneration is made before molting; the spider emerges from the old skin with scar tissue covering the end of the coxa; replacement is postponed till about a year later.

Food Requirements

Even limited observations on the activities of tarantulas by day and by night indicate that they are truly stay-at-homes. Their cruising radius about the hole is probably not more than a few inches. As a rule they are in the hole, just visible from the outside. Hence it follows that meals are not only irregular but often very far apart; that the regularity with which they feed in the laboratory, once every 5 to 7 days, is not a necessity. More direct evidence for a capacity to fast is the observed fact that during

the six months, October to April, when those in the laboratory get only water, they commonly gain in weight.

To determine the limit in the tarantula's ability to endure fasting, three mature females were deprived of food, but given water, until they died of starvation. The limits of endurance for the three were: 2 years—less 12 days; 2 years, 2 months, and 5 days; 2 years, 4 months, and 6 days. One of the females (L. D.) when molting after nine months' fasting replaced a missing leg. It molted again a year later.

The following tables show the changes in weight during the period of fasting.

10/17/30	15.3495 grams
4/1/31	15.3705 grams
10/14/31	11.8640 grams
4/11/32	12.6084 grams
10/10/32	9.3828 grams

Death occurred 12/6/32.

Another female in this test gave the following changes in weight.

10/14/31	9.2180 grams
4/11/32	8.1261 grams
10/10/32	6.5580 grams
4/6/33	6.4900 grams
10/9/33	5.6400 grams

Tarantula died 2/20/1934.

The rate of feeding is exceedingly slow. A mature tarantula given a large bird locust, *Schistocerca americana,* began the meal at 11:05 a.m. and finished at 4:22 p.m. Not counting short rest periods, 11 of them, ranging from 30 seconds to 1 minute each, the meal occupied 5 hours and 17 minutes.

The large species, *Dugesiella crinita,* occurring in northern Mexico (maximum length 85 mm.; maximum weight 54.7240 grams), will accept more food than the local species and more frequently. One or two large grasshoppers or cicadas satisfy the appetite for no longer than a day. Incidentally this species takes grasshoppers or other creatures when recently killed. It is a rather general feeder, accepting, besides various large insects, also crayfish, small lizards, small snakes, and even small fish.

Water Requirements

That spiders require water is well known. How much and how often has apparently not been determined. In all probability the requirement depends largely on the moisture content of the soil and the relative humidity of the air. The following observations and determinations are intended to give no more than a general indication of the amount of water required by tarantulas.

In seasons of severe drouth tarantulas, lacking the migratory instinct that induces black widows and other spiders to seek the necessary moisture, probably die in considerable numbers for want of water. Specimens all but dead have been found and speedily revived when supplied with water.

In north central Mexico, near Tlahualilo (State of Durango) a large colony of *Dugesiella crinita,* comprising probably many thousands of tarantulas, all but disappeared following a year (1929) when the rainfall amounted to only about 3 inches instead of the normal 9 inches.

Incidentally the water need not be clean and can be mixed with remains of insects, and may have a generous admixture of alcohol. Tarantulas will drink of this to the extent that intoxication becomes evident in spite of the eight legs to keep them steady.

A male in an advanced stage of senescence drank 1.185 grams of water (determined by weighing the tarantula before and after drinking) ; remaining over the dish, if not actually drinking, for 3 hours and 8 minutes. The weight of the water represented 15.7 per cent of the tarantula's weight.

Two mature females were put on a no-water diet on July 19 (1935). They were placed in battery jars containing about 4 inches of soil. Their food was catalpa caterpillars supplied as to the other tarantulas about once a week. One of the females died after 81 days (July 19 to Oct. 8, 1935). The other, placed in a cement-lined cave (where a part of the colony spends the winter), died between February 20 and 27, *i.e.,* after about 219 days or approximately 7 months.

Extracting the Poison

To study the effect of the poison various investigators have prepared extracts by removing and macerating the glands in physiological salt solution or some other carrier. In the case of the black

widow it has been shown by Bogen that such extracts fail to produce the effects resulting from a bite. Investigators in the Mexican Public Health Service have found evidence indicating that grinding up the last segment or telson of scorpions introduces antibodies that in part neutralize the poison. For this reason studies of scorpion venom, conducted by these investigators, are now based on poison extracted by electrical stimulation.

A so-called tetanus battery, formerly a common item in physiological laboratories, is used. The electrodes are applied to the telson and the poison is caught in a watch crystal. This method is readily adapted to tarantulas and with certain refinements can be used on the black widow. In lieu of a high-priced apparatus, now called inductometer, I used a home-made device (constructed by my colleague H. H. Schwardt). The primary coil is made of 3 turns of No. 28 magnet wire; the secondary coil is a hollow ignition coil from an automobile; and the circuit breaker consists of Ford coil points. Three dry cells provide the current. Its voltage, when the secondary coil is set so as to provide an adequate stimulus, is about 100 (measured by an electrostatic voltmeter).

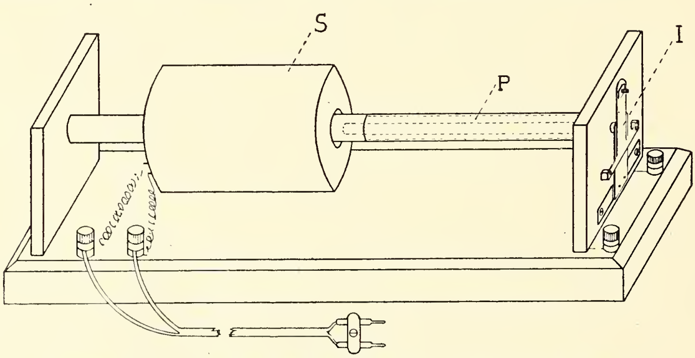

FIGURE 4. Tetanus battery used for extracting poison.

The electrodes are applied to the basal segment of both chelicerae while the fangs, bent forward, are held over the edge of a small weighing bottle. The tarantulas squirm vigorously but produce the poison without delay and have so far shown no harmful effects.

One female, having emerged early from winter quarters (about February 15), produced at the first extraction 11.2 milligrams of poison. A week later 7.9 milligrams were extracted. Early in

spring (April 16) when the tarantulas had become active, but had not fed, another extraction was made from a number of females representing in addition to the local species, four species from Mexico. The maximum quantity obtained was 58 mg., the minimum was 4 mg.; three individuals yielded almost identical amounts, 21, 20, 21 mgs.

Females as well as males of the local species, *E. californica*, are easily obtained in reasonable numbers. In addition, I have gradually acquired a fair-sized "foreign colony." During the coming season an attempt will be made to continue the study of the poison with reference to its physical and chemical properties.

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A NOTE ON LASIOPTERA MURTFELDTIANA FELT

BY E. P. FELT
STAMFORD, CONN.

This species was described in 1909 (see Journal of Economic Entomology, Vol. 2, page 288) and more fully characterized in 1916 in New York State Museum Bulletin 198, page 170, the description being drafted from U. S. National Museum material labelled August 25, 1884, from Ottawa, Kansas. The species was reared from wild sunflower seeds, only males being represented. Recently a large series of this species was received from Professor Osmond P. Breland, North Dakota Agricultural College, having been reared by him from sunflower seeds collected at Artesia, Miss., Brownsville, Tenn., Fulton, Ky., and Braidwood, Ill. The female being previously unknown it is described below, specimens being deposited in the National Museum.

Female: Length, 2.5 mm. Antennæ, short, dark brown, 19 to 21 segments, the fifth with a length about three-fourths its diameter, the terminal segment slightly produced and broadly rounded apically. Palpi, first segment short, second one-half longer, slender, the third as long as the second, the fourth one-half longer than the third, and somewhat dilated. Mesonotum, shining dark brown. Scutellum and postscutellum fuscous yellowish. Abdomen, dark brown, the segments narrowly margined with silvery. Ovipositor, nearly as long as the body, dark brown, yellowish apically, the lobes with a length three times the width. Wings hyaline, the third vein uniting with the margin at the distal third, the fifth at the distal fourth, its branch at the basal third. Halteres, yellowish transparent. Legs, a nearly uniform fuscous yellowish.

SOME HISTORICAL MATERIAL RELATING TO PROFESSOR S. S. HALDEMAN

Eventually, the activities and lives of our early entomologists are going to be written about more fully, and as the science of entomology becomes older, its devotees will become more conscious of its historical background. For this reason it is desirable to place on record the ownership and location of collections of letters, manuscripts, etc., which future historians will need to utilize. One of such collections is in the possession of Mr. Albert E. Lownes, of Providence, R. I., and Mr. Lownes has kindly permitted me to examine it and to make the following annotations. Mr. Lownes purchased this collection at auction some ten or twelve years ago in the shape of an album containing letters addressed to Professor Haldeman, sketches, pieces of manuscripts, etc. This album had been formerly in the possession of Mr. George M. Greene, to whom it had been presented in May, 1920, by Mr. Guy K. Haldeman (Professor Haldeman's grandson). A brief description of its contents follows.

Two engraved portraits of Professor Haldeman, one by A. H. Ritchie and the other by Samuel Sartain. Sartain was a skilled engraver and painter of miniatures and portraits who came to America from London in 1830.

AGASSIZ, LOUIS J. R. (L. S.) Cambridge, Nov. 13, no year.

In this letter Agassiz asks for specimens of three species of Etheastonids for a monograph on which he is working, also for alcoholic larvæ for his son who is interested in insects. He apologizes for his dictated letter, due to the feeble state of his eyes.

AGASSIZ, LOUIS J. R. (A. N. S.)

Written on the top of a four-page printed pamphlet entitled "Directions for Collecting Fishes," Cambridge, 1853.

BAIRD, SPENCER, F. (A. L. S.) Carlisle, April 29, 1846.

Baird apologizes for not calling upon Haldeman and for not getting the insect pins that Haldeman wanted. Mentions John Le Conte, Gould, Storer, Binney, Audubon, and various books.

BINNEY, AMOS. (A. L. S.) Boston, Sept. 15, 1840.

Thanks Haldeman for shells and asks for their history. Mentions death of Dr. C. I. Ward, of Ohio. Also refers to Gould, Lea.

BINNEY, W. G. (A. L. S.) Burlington, N. J., March 21, 1863.

Thanks Haldeman for the loan of shells, now being returned, except for one that was deposited in the Smithsonian Institution.

CHARLESWORTH, EDW. (A. L. S.) Museum York (?), August 31, 1846.

Mentions that he has sent to Dr. Lea, some copies of a prospectus relating to a palaentological periodical that he is editing and which Haldeman should admire. Subscribers are needed.

COUPER, J. HAMILTON (A. L. S.) Near Darien, Ga., June 10, 1841.

Refers to various shells and their habitats and to the absence of an artist in his neighborhood.

DANA, JAMES D. (A. L. S.) New Haven, Conn., May 10, 1849.

Mentions a long article submitted by Haldeman to Dana and Dana's policy of not accepting, for publication, long articles devoted to descriptions of new species. Dana suggests that Haldeman's paper be published in two parts and expresses the hope that this will not result in hurt feelings.

GIRARD, CHARLES (A. L. S.) Washington, Feb. 7, 1855.

In French.

GOULD, AUGUSTUS A. (A. L. S.) Boston, June 22, 1841.

Sends Haldeman the names of new subscribers.

GRAY, ASA (A. L. S.) Cambridge, March 25, 1863.

Acknowledges with thanks the receipt of Haldeman's gift and promises him any of the Academy's publication that he desires. He returns postage that Haldeman used and expresses regret that Haldeman and his family have suffered from the flood.

HALDEMANN, S. S. (A. M. S.)

"Description of a New Genus of Scarids." Description of *Cryptopus nitens.*

HARRIS, THADDEUS W. (A. M. S.)

"Specimens of Nomadæ in the Collection of T. W. H. lent to Professor Haldeman to be described." A list.

HENTZ, NICHOLAS M. (A. L. S.) Florence, Ala., August 22, 1842.

Mentions a collection of insects being shipped by a boat that will carry it to the mouth of the Tennessee. From there it will be forwarded to Pittsburgh and then to Philadelphia where it is directed to Messrs. Rich'd Paxson & Sons who will deliver it. Camphor was placed in every drawer. Every pin was secured. Every insect was washed three times in a mixture which Hentz had mentioned in a previous letter. Paper was pasted over every joint and crack. The case was enclosed in a water-tight box.

LEA, ISAAC (A. L. S.) (Philadelphia) May 7, 1860.

Thanks Haldeman for a tracing made from a Rafinesque manuscript and for a reference. Mentions Say, Rafinesque, Binney, and scientific matters.

LECONTE, JOHN E. (A. L. S.) New York, November 29, 1858.

As for news about Haldeman and other entomologists. Mentions his son John, in California, and his several hundred new species, also the fact that John had found all Eschscholz's species except three. Asks if Academy had received any insects from John Bell. John E. LeConte was a coleopterist and the father of John L. LeConte.

LECONTE, JOHN L. (A. L. S.) Philadelphia, Feb. 18, 1857.

Inquires about Haldeman, also of Horace. Mentions a trip south which his father expects to take and hopes that he can pay Haldeman a visit before spring. Requests that Haldeman have forwarded a letter addressed to John LeConte presumably in the Columbia Post Office.

MELSHEIMER, F. E. (A. L. S.) Dover, York County, April 8, 1853.

Acknowledges letter from Haldeman. Speaks of having been ill during the winter of 1852 and during much of the previous summer and autumn. This illness kept him away from entomological matters, etc. States that he has not been in York since Dr. LeConte left insects in care of Mr. Ziegler, etc. Ends with "God bless you."

MORRIS, JOHN G. (A. L. S.) Philadelphia, May 10, no year.

Morris mentions his visit to New York. Expects to see Haldeman next week. Asks him to prepare a letter to Morton, the librarian of the Academy.

MOTSCHULSKY, VICTOR I. (A. L. S.) St. Petersburg, May 28, 1859.

In French.

OSTEN-SACKEN, BARON R. (A. L. S.) Washington, Oct. 24, (1856?).

Asks if Haldeman had received a previous letter relative to Neuroptera desired by Dr. Hagen.

RAFINESQUE, C. S. (A. M. S.).

"On a new Salamander and a new Stellio from Kentucky," discovered in 1823. Second page contains a poem that appears to be in Rafinesque's handwriting.

SAY, LUCY (A. L. S.) New Harmony, Apr. 13, 1840.

Relates to shells.

SCHAUM, HERMAN R. (A. L. S.) New Orleans, April 3, 1848.

In German.

SILLIMAN, JR. B. (A. L. S.) Louisville, Ky., February 23, 1854.

Refers to a manuscript on the numerals of the Waco Indians sent to Haldeman by Silliman.

STURM, J. H. C. (A. N. S.)

Inscription on a pamphlet about beetles, Nürnberg, Dec. 10, 1861.

TRYON, GEORGE W., JR. (A. L. S.) Philadelphia, Oct. 31, 1863.

Relates to shells. Wants photograph of Haldeman in exchange for his own which is enclosed. Written on a letterhead of Tryon & Brother, "Wholesale Gun Dealers," of Philadelphia.

VAUX, WILLIAM S. (A. L. S.) Philadelphia, March 27, 1868.

Refers to express package containing parts of Journal, new series.

ZIEGLER, DANIEL (A. L. S.) York, Pa., Oct. 13, 1848.

Describes *Cryptoceph. venustus* and *C. ornatus.*

Original paintings for plates 6, 9, 12, 15, 26, 32, 33, 35 and 36, for Say's "Entomology," by Peale, LeSueur, Wood, and Bridport, with uncolored proofs of 26, 32, 33, 35 and 36.

Thirteen drawings by Joseph Leidy, one by W. W. Wood, and twenty-three by unnamed artists, principally of insects.

Thirty original paintings by Helen E. Lawson for Haldeman's "Monograph of Limniades," etc. Two title-pages for this work and proof of one engraving.

H. B. WEISS

THE DEVELOPMENT AND GENERAL BIOLOGY OF CREOPHILUS VILLOSUS GRAV.

BY CYRIL E. ABBOTT
CHICAGO, ILLINOIS

As the largest and most conspicuous of our native Staphylinidæ, *Creophilus villosus* Grav. is of unusual interest. This paper proposes to discuss the results of observations on the development, general biology, and certain aspects of anatomy; a summary of work carried on for several years past.

GENERAL HABITS

Adult specimens of the beetle are generally found on or about the carcasses of animals lying in the open country. Although they may also be found in wooded regions, the species is primarily one of open fields, where it may occur in great numbers. Specimens sometimes are attracted from a considerable distance; for instance, one flew into the open window of an elevated car in the heart of Chicago. Although the beetles apparently orient to decaying material chiefly in flight, they will also emerge from their subterranean resting-places if a carcass is not too far distant.

Very few adults occur in midsummer. They appear in greatest numbers in the Chicago region in late May, and again in somewhat lesser numbers in September. The following record of numbers at various periods of the summer will indicate this more clearly:

May 2	12	May 22	35
May 8	18	July 19	5
May 11	19	Aug. 2	5
May 12	34	Aug. 27	1
May 15	24	Oct. 6	11

Unfortunately I have no exact records for September, but the number for October given above indicates a decline due to the coming of cold weather. It should also be remembered that these records are not of a few observations during one season, but merely samples of what has been observed over a period of years.

Creophilus feeds on fly maggots and other insects found on and about decaying matter. This has been proved not only by laboratory experiments but by observations in the field. When pressed, the adults will often attack decaying meat, but the larvæ never have been observed doing so. Both larvæ and adults are highly predatory; of some thirty larvæ, kept in a large container of earth, only five escaped being eaten and so reached maturity. When placed together in a small container, both adults and larvæ "snap" vigorously at one another in a manner which is almost repulsive to the onlooker.

Both larvæ and adults feign death, when touched or suddenly exposed, by flexing the abdomen ventrally until the body forms a ring. This condition never lasts more than a few seconds, nor can it, like that of some insects, be readily reinduced.

Mating usually occurs with the copulatory organs alone in contact, so that the insects lie with their heads pointed in opposite directions. Sometimes the stronger of the pair drags the protesting mate over the ground as it runs. Mating may last at least an hour, although external factors easily disrupt the union.

Description of Stages

Egg: Length, 2.0–3.0 mm.; width, 1.5–2.0 mm.; ovoid, symmetrical, nearly prolate; opaque, white to cream; thin-shelled; collapsing when preserved. (Fig. 1.)

Larva: When newly emerged the larva is from 5.5–6.0 mm. in length, with the greatest width 1.2–1.5 mm. Prior to pupation it reaches a length of 25.0–30.0 mm., with a width of from 5.0 to 7.0 mm. The *head* of the larva, like that of the adult, is circular and compressed; the eyes consisting of four simple ocelli on either side of the head (Fig. 6); the antennæ, placed far forward, almost between the jaws, are 3-segmented and about 2.0 mm. long. Dorsally the *prothorax* is broad, sclerotized, and dark; the sternal plate is triangular, with the apex caudad, and covers only the anterior half of the prothorax. The *mesothorax* and *metathorax* are essentially similar. Dorsally each is supplied with a pair of dark, sclerous plates; bilaterally arranged, and separated by a space about .01 mm. in width. There is no ventral sclerotization. All the *abdominal* segments, excepting the terminal one, are simi-

lar. Each has, like the thoracic segments just described, two dorsal plates, separated by a space of about .05 mm.; two bilaterally arranged, hexagonal, ventral plates; two epipleural plates, on either side of the segment, the larger anterior and elongated, the smaller posterior and circular; and on either side one subpleural, elongated plate. All these plates are dull brown and sparsely set with short hairs. The intervening spaces appear white from subcuticular fat. The *terminal* abdominal segment differs from the others in being heavily sclerotized throughout, as well as dark and hirsute; the cerci, which are attached dorsally and project dorso-caudally, are 3.0 mm. in length, sclerotized and hirsute; they are 3-segmented, the 2nd segment being considerably shorter than the other two. Ventrally the terminal abdominal segment forms a tubular prolongation (2.0 mm.) through which the anus opens. (See Fig. 5, and the student drawing, Fig. 6.)

The *legs* of the larva are all similar. The subcoxa is reduced and apparently double; the coxa large, elongated, and broad at the base; the trochanter prominent and sclerous; the femur moderately long and enlarged distally; the tibia narrow and about the same length as the femur (1.0 mm.), the tarsus a mere spike (0.5 mm.). All parts of the leg are set with spines, those on the femur being arranged in two ordered rows. (These are not shown in Fig. 8.)

The *mesothoracic spiracle* is conspicuously large; the *metathoracic* located between the 2nd and 3rd pairs of legs, very small. The *abdominal spiracles* are moderately conspicuous, but decrease regularly in size as the termination of the abdomen is approached. They are all sclerous and dark.

Pupa: Length, 15.0 mm.; greatest width, 5.0 mm.; translucent brown when newly formed, gradually becoming black. The *legs, posterior wings,* and *jaws* are folded against the sternum; the *antennæ* cross the bases of the jaws just under the eyes to fold back, the distal ends directed caudad. The *elytra* are folded close to the body over the wings, with their distal ends directed caudoventrally, but not completely covering the wings; in fact not reaching beyond the pleura. The *abdominal spiracles* are dorsal, elevated, and conspicuous. The *eyes* are somewhat darker than the rest of the body. A conspicuous, narrow, transverse ridge,

nearly black, and set with a single row of hairs evenly spaced, traverses the anterior part of the pronotum. (Figs. 3 and 4.)

Adult: The adult is too well known to require description. When newly emerged it is very glossy. (Fig. 2.)

DEVELOPMENTAL BEHAVIOR

The duration of incubation is about 48 hours. An average taken from twenty-two specimens places the larval stage in summer at about 23 days. The average duration of the pupal stage is 12 days. This makes the total duration of development approximately 37 days.

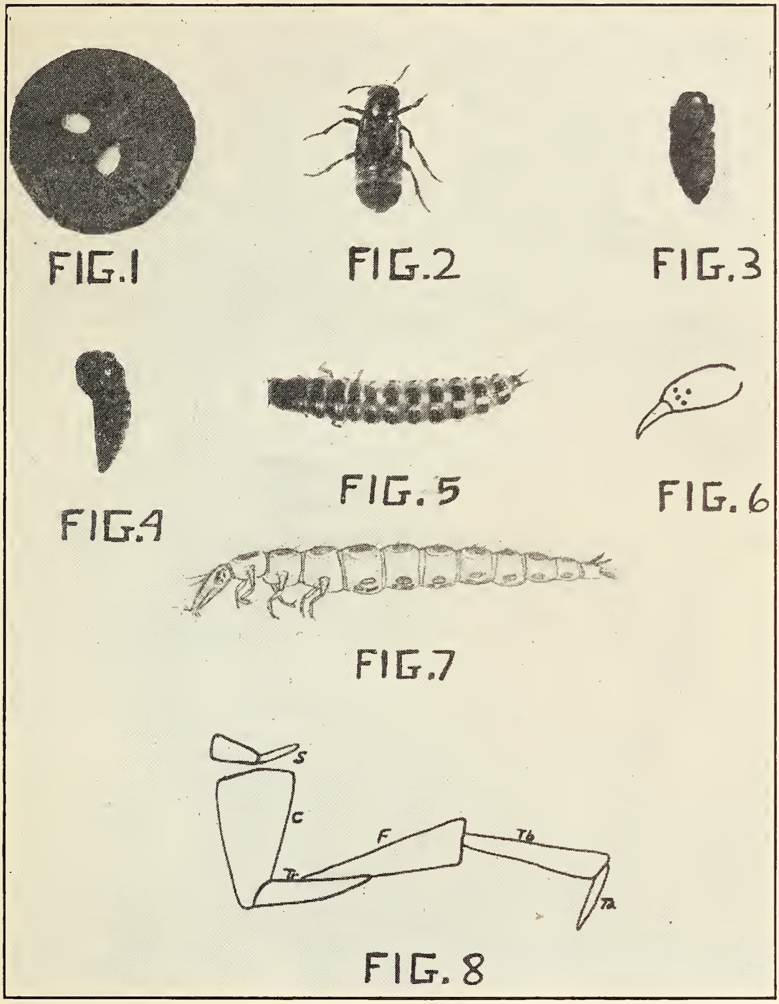
Although eggs may be deposited upon the surface of the ground, it is more usual to find them from 1–5 cm. below the surface. I have not seen larvæ emerge from eggs, but those emerging from molt are nearly white. It requires about 3 hours for the larva to reach full coloration after ecdysis. The number of instars is not known.

Larvæ normally remain pretty much below the surface of the soil. When about to pupate the larva shortens, thickens, and remains partially flexed ventrally. It may remain in this condition 2 or 3 days before the final transformation to pupa. The nature of the soil permitting, the insect forms an oval cavity in which the pupa lies. This is probably produced by movements of the larva prior to pupation.

I wish to extend a word of thanks to my pupil, Wm. Gedzun, for permission to use the drawing constituting Fig. 7.

PLATE I

Figure 1. *Creophilus villosus,* eggs.
Figure 2. *C. villosus,* adult.
Figure 3. *C. villosus,* ventral aspect of pupa.
Figure 4. *C. villosus,* lateral aspect of pupa.
Figure 5. *C. villosus,* larva.
Figure 6. *C. villosus,* sketch of larval head, left lateral aspect, showing the ocelli.
Figure 7. *C. villosus.* Student sketch, left lateral aspect, of larva.
Figure 8. *C. villosus.* Larval leg. The parts indicated are: S, subcoxa; C, coxa; Tr, trochanter; F, femur; Tb, tibia; Ta, tarsus.



CREOPHILUS VILLOSUS

STUDIES IN AMERICAN SPIDERS: MISCELLANEOUS GENERA OF ERIGONEÆ, PART II

BY S. C. BISHOP AND C. R. CROSBY

We take this opportunity to express our thanks to the authorities of the Museum of Comparative Zoology, especially to Professor Nathan Banks and to Miss Elizabeth B. Bryant, for the privilege of studying the types of the species described by Emerton, Banks and Chamberlin. We have always received a cordial welcome at the Museum and have been given every facility for carefully studying the specimens and for making drawings of unique types. Without this cooperation it would have been impossible to prepare this series of revisions of the Erigoneæ.

SCOTINOTYLUS Simon

Ar. Fr. 5: 501. 1884

Type: *Erigone antennata* Cambridge.

The embolic division has a spirally coiled tail-piece and a very long slender coiled embolus. The tibia of the male palpus is armed with two enlarged spines. Scotinotylus is related to Spirembolus, Tortembolus and Cochlembolus.

A single specimen of the type species has been collected in America, near snow on Mt. Rainier, Washington.

Scotinotylus antennatus Cambridge

(Figures 1–3)

Erigone antennata Cambridge, Zool. Soc. Lond. Proc. 1875, p. 197, pl. 27, f. 7.

Erigone aries Kulczynski, Pam. Akad. Krakow. 8: 17, pl. 2, f. 11. 1882.

Scotynotylus antennatus Simon, Ar. Fr. 5: 502, f. 287–290. 1884.

Scotynotylus antennatus Calloni, Fauna nivale, p. 134, 264, 265. 1889.

Scotynotylus aries Chyzer & Kulczynski, Ar. Hung. 2: 95. 1894.

Scotynotylus antennatus Kulczynski, Bul. Intern. Acac. Sci. Cracovie, 1905, p. 552.

Scotynotylus antennatus de Lessert, Cat. Ar. Suisse, p. 169. 1910.
Scotynotylus antennatus Simon, Ar. Fr. 6: 373, f. 665. 1926.

MALE. Length, 1.5 mm. Cephalothorax dull orange yellow, lightly suffused with dusky, darker along the margin; viewed from above, rather broad, the sides rounded on the posterior half, converging in front, broadly rounded across the front; viewed from the side steeply ascending behind, then more gradually to back of the head, rounded over the back of the head to the posterior median eyes; top of head nearly level. Clypeus very wide, slightly concave just below the eyes and then convex and somewhat protruding. Sternum nearly black over yellow, convex, smooth and shining, posterior coxæ separated by almost the diameter. Endites pale orange yellow lightly suffused with dusky. Legs light orange yellow. Abdomen gray.

Posterior eyes in a recurved line, the median separated by a little more than the diameter and from the lateral by three times the radius. Anterior eyes in a slightly procurved line, the median smaller than the lateral, separated by two-thirds the diameter and from the lateral by twice the diameter. On each side just back of the anterior median eye there is a long, stout, blunt spine directed forward.

Femur of palpus rather stout, compressed, curved inward. Patella long, curved downward, thicker distally. Ratio of length of femur to that of patella as 20 to 16. Tibia very short ventrally, dorsally elevated and produced forward into a pointed process which in dorsal view is broadly rounded on the mesal side, excavated laterally, armed with a stiff spine at the edge of the excavation; in side view the tip of this process appears strongly incurved. The tibia is armed at base, dorsolaterally with a very long, stout, spine. Cymbium dorsally angulate at base, truncate at tip, with a broad, deep groove near the lateral margin. Paracymbium thin, lying nearly in one plane, bent at a right angle, broader beyond the bend, rounded at tip with a shallow, rounded notch. Bezel narrow and high. Tail-piece of the embolic division broad and spirally curved, the tip rounded with a rounded projection next to the cymbium. The tail-piece gives rise directly to a very long, slender, style-like embolus which after making one turn inside the bulb emerges on the mesal side of the bezel and then makes a

larger, flat turn around the end of the bulb, the very fine tip lying behind the bezel. The median apophysis appears as a finger-like process lying between the inner and outer turns of the embolus.

Type locality: Col des Ayes, Casset, France.

Washington: Mt. Rainier, Paradise Camp, near snow, Aug. 22, 1927. 1 ♂.

Compared with a specimen from France, determined by Simon.

SISICOTTUS new genus

Type: *Tmeticus montanus* Emerton

In this genus the tibia of the male palpus is armed with a dorsomesal process of only moderate length. The embolic division has a bulb-like tail-piece from which there arises a style-like embolus which lies in an open coil of one turn on the end of the bulb.

KEY TO SPECIES, MALES

Dorsomesal process of the tibia long, as in figures 5 and 6............*montanus* Em.
Dorsomesal process shorter, as in figures 9 and 10........................*montigenus* n. sp.

Sisicottus montanus Emerton

(Figures 4–8)

Tmeticus montanus Emerton, Conn. Acad. Sci. Trans. 6: 55, pl. 16, fig. 3. 1882.

Erigone collina Marx, U. S. Mus. Proc. 12: 533, 538, 593. 1890.

Œdothorax montanus Crosby, Phila. Acad. Nat. Sci. Proc. 1905, p. 312.

Grammonota orites Chamberlin, Ent. Soc. Am. An. 12: 249, pl. 17, figs. 7–8. 1919.

Gongylidium montanus Emerton, Royal Can. Inst. Trans. 12: 315. 1919.

Œdothorax nesides Chamberlin, N. Y. Ent. Soc. Jour. 29: 36, pl. 3, f. 1. 1921.

Œdothorax pidacitis Crosby and Bishop, N. Y. Ent. Soc. Jour. 35, p. 151, pl. 16, f. 17–18. 1927.

Œdothorax orites Chamberlin and Ivie, Univ. Utah Bul. 23 (4): 22, pl. 5, fig. 48. 1933.

MALE. Length, 1.7 mm. Cephalothorax dark dusky orange, darker at the margin; viewed from above evenly rounded on the sides, only slightly convergent towards the front, bluntly rounded across the front; viewed from the side, steeper behind but rounded to the posterior eyes. Clypeus slightly convex and protruding.

Sternum dusky orange, nearly black, rather broad, rounded on the sides behind, bluntly produced between the posterior coxæ which are separated by less than the diameter. Endites orange yellow. Legs and palpi bright orange yellow. Abdomen dark greenish gray, almost black. Posterior eyes in a slightly procurved line, equal, the median usually separated by less than the diameter and a little closer to the lateral but in some specimens they are separated by the diameter. Anterior eyes in a straight line, the median smaller than the lateral, separated by less than the radius, a little closer to the lateral. Clypeus as wide as median ocular area.

Femur of palpus long, slender, and quite strongly curved. Patella short and strongly arched over the back. Ratio of length of femur to that of patella as 20 to 6. Tibia short and deeply excavated, the dorsolateral angle deeply and broadly emarginate with a very short, broad lobe in the middle of the excavation; the excavation bounded on the dorsal side by a broad triangular process tipped with a short black tooth directed laterally, and bounded laterally with a broad, triangular, round-pointed tooth. The paracymbium consists of two parts; a thick, rounded basal part and a slender, strongly hooked terminal part. The embolic division has a large pear-shaped tail-piece which connects directly with the base of the embolus, the latter stout and black and lying back under the cymbium. The terminal, whip-like part of the embolus arises deep back in the alveolus and curves around to emerge from the edge of the cymbium on the lateral side some distance from the tip. It is protected by a conspicuous pointed conductor. The median apophysis appears as a sharp, black tooth lying within the curve of the embolus.

FEMALE. Length, 1.7 mm. Similar to the male in form and color. Epigynum convex, broader behind, with a broad emargination which is convexly rounded on the sides and square across the middle. In this notch the middle lobe can be seen as a short, transverse, inverted T-shaped plate. The curved inner margins of the lateral lobe diverging in front can be seen through the integument.

Type locality: Mt. Washington, N. H.

This species varies somewhat in different parts of its range and

has received several names. Emerton described *montanus* from Mt. Washington, New Hampshire. In 1921 Chamberlin described *nesides* from St. Paul Island, Alaska. The type of *nesides* in the Museum of Comparative Zoology has lost all but the front right leg. The abdomen is loose and shriveled. The palpi are practically the same as in typical *montanus;* the posterior eyes are separated by about the diameter of an eye and the relative width of the eye-group is greater. In 1919 Chamberlin described *orites* from the mountains of Utah. A comparison of types shows that *orites* is identical with *montanus.* In 1927 we described *pidacitis* from Pingree Park, Colorado. This form of *montanus* is a little larger and usually somewhat paler than typical specimens from the east. The genital bulb is the same. The tibia of the male palpus of the two forms are shown together in Figs. 5 and 6. We at first thought we might be able to distinguish these forms by the distance between the posterior median eyes but have decided that this character cannot be depended upon. We first separated our male specimens into two lots, placing in *pidacitis* the larger paler forms with the tibia of the type shown in Fig. 5; in *montanus* we placed the smaller, darker forms with the tibia as in Fig. 6. We then measured the distance between the posterior eyes with the results shown in the tabulation on the following page.

For the present at least it seems best to consider these forms merely as races of *montanus.* On the mountains of New England and New York only typical *montanus* is to be found. In the Western States both forms may occur in the same localities.

Quebec: Ile d'Alma, Lac St-Jean, July 28, 1934, 3 ♂; Bagotville, July 26, 1934, 6 ♂.

Maine: Presque Isle, Aug. 26, 1925, 3 ♂ 16 ♀; Long Island, April 27, 1906, 1 ♂ (Bryant).

New Hampshire: Franconia, 1 ♂ (Banks).

New York: Uphill Brook and Opalescent River, Essex Co.; July 1918, 2 ♂ 7 ♀; High Falls, Essex Co., Aug. 23, 1921, 1 ♂ 1 ♀; Mt. MacIntyre, Essex Co., July 1, 1923, 5 ♂ 1 ♀; July 24, 1925, 2 ♂; Mt. Whiteface, Essex Co., Aug. 24, 1916, 27 ♂ 14 ♀; Sept. 13, 1931, 8 ♂ 7 ♀ (Hammer); Aug. 25, 1921, 2 ♂ 2 ♀; Lake Tear, Mt. Marcy, Essex Co., Sept. 4, 1922, 8 ♂ 4 ♀; Artist's Brook, Chapel Pond, Essex Co., Aug. 24, 1930, 2 ♂; Sept. 7, 1931, 3 ♂

2 ♀; June 11, 1933, 6 ♂; Oct. 20, 1934, 3 ♂ 3 ♀; Avalanche Lake, July 24, 1925, 2 ♂.

Vermont: Mt. Mansfield, June 4, 1927, 3 ♂; July 5, 1935, 7 ♂ 7 ♀.

Wyoming: Grand Canyon, Yellowstone Park, Aug. 30, 1927, 1 ♂; Sylvan Pass, Aug. 31, 1927, 1 ♂.

Washington: Seattle, Spring, 1932, 3 ♂ (Exline).

Alberta: Sulfur Mt., Banff, Aug. 2, 1927, 1 ♂.

British Columbia: Metlakatla, several ♂ ♀ (Emerton); Yoho Glacier, Aug. 5, 1914, many ♂ ♀ (Emerton).

	Number of specimens posterior median eyes separated:	
	By the diameter	By less than the diameter
pidacitis		
Mt. Rainier	1	1
Sylvan Pass, Yellowstone Park	1	
Grand Canyon, Yellowstone Park	2	
Yoho Glacier, B. C.		1
Metlakatla, B. C.		1
montanus		
Presque Isle, Me.	2	
Mt. Mansfield, Vt.		3
High Falls, N. Y.		2
Avalanche Lake, N. Y.		2
Chapel Pond, N. Y.	1	4
Mt. Whiteface, N. Y.	1	12
Uphill Brook & Opalescent R., N. Y.		1
Mt. MacIntyre, N. Y.	3	4
Banff, Alta.		1
Grand Canyon, Yellowstone Park		1

This species has also been recorded by Emerton from Labrador: Battle Harbor; Quebec: Lake Megantic; Maniwaki; Ontario: Minaki; British Columbia: Laggan; Jasper; Saskatchewan: Prince Albert.

Sisicottus montigenus new species

(Figures 9–11)

MALE. Length 1.5 mm. Cephalothorax dark gray over yellowish, evenly rounded on the sides, narrowed towards the front, broadly rounded across

the front; viewed from the side rather steeply ascending behind to the cervical groove, than more gently ascending to the back of the head and then evenly and gently rounded over to the posterior median eyes. Clypeus nearly straight and slightly protruding. Sternum and labium dark gray over yellow. Endites somewhat lighter. Legs and palpi orange yellow. Abdomen gray.

Posterior eyes in a straight line, the median separated by the diameter and a little nearer to the lateral. In another specimen taken with the type the posterior eyes are separated by less than the diameter. Anterior eyes in a slightly procurved line, the median smaller than the lateral, separated by the radius and from the lateral by a little more.

Femur of palpus slightly curved inward, a little wider distally. Patella short. Ratio of length of femur to that of patella as 19 to 6. Tibia longer than patella, widened distally, the dorsal margin on the mesal half evenly rounded, the dorsolateral margin with a broad, shallow excavation bounded mesally with a short black tooth. The paracymbium armed at base with a row of three short stiff hairs; on the ventral side of the palpus greatly enlarged and reaching the opposite edge of the cymbium, the tip relatively slender with a shallow notch before tip. The embolic division has a large pear-shaped tail-piece which connects directly with the base of the embolus, the latter stout and black and lying back under the cymbium. The embolus is a black style that arises deep back in the alveolus and curves around to emerge from the edge of the cymbium on the lateral side some distance from the tip. The genital bulb is closely similar to that of *montanus*.

In the specimens from Mt. MacIntyre there is some variation in the size of the tooth on the tibia of the male palpus and in the number and size of the hairs on the base of the paracymbium. See figures 9 and 10.

FEMALE. Similar to the male in form and color. Posterior eyes equal, in a slightly procurved line, the median separated by three-fourths the diameter, a little closer to the lateral. Anterior eyes in a very slightly procurved line, the median distinctly smaller than the lateral, separated by two-thirds the diameter and from the lateral by a little more. The epigynum is distinctly protuberant, the median fovea squarish, rounded in front, the lateral walls convex mesally. A median septum slightly widened anteriorly faintly indicated.

Holotype, ♂, allotype ♀, Mt. Mitchell, N. C., Oct. 12, 1923. 1 ♂ and 3 ♀ paratypes from the same locality.

New York: Mt. MacIntyre, Sept. 4, 1927, 2 ♂; July 1, 1923, 1 ♂; Lake Tear, Mt. Marcy, Sept. 4, 1922, 1 ♂.

SISICUS new genus

Type: *Sisicus penifusiferus* n. sp.

In this genus the tibia of the male palpus is broadly produced into a rounded lobe. The tail-piece of the embolic division is broad, flat, rounded;

the embolus is long, slender and coiled into a spiral along with the extraordinarily elongate median apophysis.

Sisicus penifusiferus new species

(Figures 12–13)

MALE. Length, 1 mm. Cephalothorax yellow lightly suffused with dusky, darker at margin and in a small patch at the cervical groove; viewed from above, noticeably broad, evenly rounded on the sides without any constriction at the cervical groove, broadly rounded across the front; viewed from the side, evenly and steeply ascending in a straight line to the cervical groove, then evenly and broadly rounded over to the posterior median eyes. Clypeus nearly straight and slightly protruding. Sternum gray over dull yellow, broad, convex; labium gray; endites yellow, lighter distally. Legs pale yellow. Abdomen dark gray.

Posterior eyes in a straight line, equal, the median separated by the diameter and a little farther from the lateral. Anterior eyes in a straight line, the median smaller than the lateral, separated by a little less than the radius and from the lateral by the diameter.

Femur of palpus moderately long, slightly curved, slightly widened distally. Patella short and broad. Ratio of length of femur to that of patella as 15 to 6. Tibia obconic with the mesodorsal angle produced into a broad, thin, rounded lobe. Paracymbium at point of attachment square and thickened. It then narrows gradually to the beginning of the curve, this basal part provided with a sharp longitudinal keel, branched at base; the curved part of the paracymbium very slender, the tip widened. The tail-piece of the embolic division quadrate, with a rounded excavation distally, the lateral angle bluntly angulate. The tail-piece gives rise to a long, moderately slender, style-like embolus which is coiled around a grooved spool, the tip lying in a pointed projection on the end of the spool. This spool seems to represent the median apophysis; it is, however, a separate sclerite being articulated with the tegulum by means of an elongate, thin, flat, process. The spool proper is black and is spirally grooved for the reception of the embolus. It is armed at base, ventrolaterally, with a long, slender, curved tooth.

FEMALE. Length, 1 mm. Similar to the male but lighter. The epigynum is nearly circular and is largely occupied by an immense cavity, divided in front by a double median line indicating the position of the ducts; the anterior half of the rim is narrowly chitinized; a broader band borders the cavity on the sides, behind, and in the middle there is an erect rounded lobe.

Holotype, male, Avalanche Lake, N. Y., July 24, 1925; allotype, female, Arnprior, Ontario, April, 1934.

New York: Lake Pleasant, April 27, 1924, 1 ♂; Peru, Oct. 22, 1934, 1 ♂.

Maine: Molunkus Pond, Aug. 25, 1925, 1 ♂.

Ontario: Arnprior, April, 1934, 4 ♂ 3 ♀ (C. Macnamara).

SCOLOPEMBOLUS new genus

Type: *Arœoncus littoralis* Emerton.

In this genus the tibial armature of the male palpus consists of two processes of moderate length. The tail-piece of the embolic division is long, slender, undulating and gives rise directly to a pointed embolus.

KEY TO SPECIES, MALES

Dorsal process of tibia pointed..*melacrus* Chamb.
Dorsal process of tibia broader and rounded...*littoralis* Em.

Scolopembolus littoralis Emerton

(Figures 14–15)

Arœoncus littoralis Emerton. Conn. Acad. Sci. Trans. 18: 214, pl. 1, fig. 6, 1913.

MALE. Length, 1.5 mm. Cephalothorax chestnut brown, head lighter; viewed from above, evenly rounded on the sides without a constriction at the cervical groove, broadly rounded across the front; viewed from the side, evenly and gently rounded over from the posterior margin to the posterior median eyes. Clypeus broad, gently convex and slightly protruding, clothed with a few erect hairs. Sternum orange, strongly suffused with dusky, darker at the margin. Endites dull orange, lighter distally. Legs orange yellow. Abdomen dark gray.

Posterior eyes in a slightly procurved line, equal, the median separated by the diameter and from the lateral by nearly twice the diameter. Anterior eyes in a procurved line, the median smaller than the lateral, separated by less than the radius and from the lateral by twice the diameter.

Tibia obconic, with a smooth rounded notch in the dorsal margin, mesal angle broadly rounded, the dorsolateral angle produced into a short rounded tooth. Tegulum strongly developed, protuberant ventrally. Tail-piece of the embolic division thin, extending beyond the edge of the tegulum. The embolus is a short black tooth arising from the base of the tail-piece.

Type locality: Lyme, Conn.

Described from the type, 1 ♂, Oct. 8, 1911. In wet hay on edge of marsh.

Scolopembolus melacrus Chamberlin

(Figures 16–17)

Œdothorax melacra Chamberlin. Mus. Comp. Zool. Bull. 60: 236, pl. 17, f. 6, 7. 1916.

MALE. Length, 2 mm. Cephalothorax yellowish orange with a faint tinge of reddish, narrowly margined with gray; viewed from above broadly rounded on the side, slightly constricted at the cervical groove, broadly rounded across the front; viewed from the side, gradually ascending to the posterior median eyes, gently rounded over the head. Clypeus straight and slightly protruding. Sternum dark gray over yellow, strongly convex, produced between the posterior coxæ which are separated by less than the diameter. Endites pale orange-yellow, chelicerae with a tooth on face. Legs long and slender, pale yellow. Abdomen pale in front, blackish posteriorly.

Posterior eyes in a straight line, equal, the median separated by three-fourths the diameter and from the lateral by the radius. Anterior eyes in a very slightly recurved line, the median smaller than the lateral, separated by half the radius and from the lateral by the same distance.

Femur of palpus gently curved inward and downward. Ratio of length of femur to that of patella as 26 to 10. Tibia narrow at base, gradually widened distally, the dorsal margin thin and smooth, evenly rounded on the mesal corner, strongly concave at the base of the dorsolateral process. The latter rather broad, ending in two points, the upper one black, triangular; the lower one has the tip bent abruptly downward to form a blunt tooth. Paracymbium large, strongly curved; the flattened outer part has the mesal angle square, the tip tongue-like, without notch. Tail-piece of embolic division long extending beyond the edge of tegulum to the edge of the cymbium, the tip broad and rounded, constricted from the broader basal part. The embolus, borne on the mesal angle of the tail-piece, is a rather stout, gently curved style which lies in a channel in the median apophysis.

Type locality. Cuzco, Peru.

California: Ocean Beach, Ingleside, Nov. 29, 1919, 1♂ (H. Dietrich).

Washington: Seattle, Oct. 28, 1932, 1 ♂ (Exline).

We compared the California specimen with the type in M.C.Z. and found that they are undoubtedly identical except that the type is considerably larger and more maturely colored.

FEMALE. Very similar to the male from Peru. The epigynum has a nearly quadrate middle lobe, greatly narrowed in front where it separates two large, nearly circular openings. The receptacles are small and show through the integument close to the lateral edges of the openings.

TRÆMATOSISIS new genus

Type: *Aræoncus bispinosus* Emerton.

This genus is very close to Sisis but the male is provided with cephalic pits. The patella of the male palpus is long and swollen. The tibia is provided with a very long slender process.

Træmatosisis bispinosus Emerton

(Figures 18–21)

Aræoncus bispinosus Emerton. Conn. Acad. Sci. Trans. 16: 389, pl. 1, fig. 7. 1911.

MALE. Length, 1.4 mm. Cephalothorax dull brownish with darker radiating lines; viewed from above broad, rounded on the sides, rapidly narrowing forward, truncate in front, the eyes borne on a narrow lobe. Cephalothorax viewed from the side, gently arched behind to the base of the cephalic lobe, then strongly elevated and arched over the back of the head to the posterior median eyes; the median ocular area straight, slanting slightly forward. Cephalic pits very small, circular, lying close behind the posterior lateral eyes in a shallow groove. Clypeus concave below the eyes, then convex and slightly protruding. Sternum dark brown, broad, the posterior coxæ widely separated. Endites dull orange yellow mottled with dusky. Legs yellowish. Abdomen dark gray.

Posterior eyes when viewed from directly above slightly procurved, nearly straight. Anterior eyes in a gently procurved line, the median smaller than the lateral, separated by the radius and a little farther from the lateral. The posterior median eyes are borne on the top of the cephalic lobe.

Femur of palpus relatively short, nearly straight. Patella

straight, stouter than femur. Ratio of length of femur to that of patella as 17 to 13. Tibia swollen and enlarged dorso-mesally; the dorsal margin depressed and thin, armed with a very long, slender process that lies close to the back of the cymbium. Back of the depressed area there is a diagonal ridge, highest at the mesal end and armed mesally with a row of four evenly spaced stiff hairs. On the right palpus there is only one tibial process but on the left one there is another shorter curved one just back of the base of the long one. Paracymbium small, thin, strongly curved. Tail-piece of the embolic division slender in the basal part; the tip, which lies over the edge of the cymbium is sharply angulate and hooked back with the apex acute. The embolus is a long slender style, double basally, which first makes one large turn and then ends in a much smaller coil.

In the form of the embolic division and the armature of the tibia of the male palpus the species approaches Spirembolus.

FEMALE. Length, 1.4 mm. Similar to male but the head is less elevated. The epigynum has the lateral lobes nearly meeting in the middle with the inner margin semicircularly rounded, leaving the middle lobe hour-glass-shaped. Female described from specimens from Oswego County, N. Y.

Type locality: Springfield, Mass.

Redescribed from the type, 1 ♂, Sept. 20, 1909.

New York: Mud Pond, Oswego, Oct. 15, 1935, 1 ♂ 4 ♀. Sifted from moss in a bog.

SISIS new genus

Type: *Lophocarenum rotundum* Emerton.

In this genus the tail-piece of the embolic division is long and slender; the embolus is very long, arises from the base of the tail-piece in the interior of the bulb and lies in a flat coil on the ventrolateral face of the bulb. The tibia is armed with a rather long process.

Sisis rotundus Emerton

(Figures 22–24)

Lophocarenum rotundum Emerton. Can. Ent. 57: 67, fig. 3. 1925.

MALE. Length 1.8 mm. Cephalothorax chestnut brown with faintly developed darker radiating lines and darker margin.

Viewed from above, noticeably broad, the sides evenly rounded without any constriction at the cervical groove, strongly converging to the bluntly rounded front. Anterior eyes in profile. Cephalothorax viewed from the side steeply ascending behind and then very gradually ascending in an almost straight line to the posterior median eyes; the median ocular area slanting sharply forward; clypeus nearly straight and slightly retreating. Sternum reddish-brown strongly suffused with dusky, darker at the margin, broad, convex, smooth and shining. Labium brown; endites orange yellow suffused with dusky, lighter distally. Legs and palpi orange; the patellæ lighter, the coxæ below with a narrow band of black at tip. Abdomen dark greenish gray.

Posterior eyes in a straight line, equal and equidistant, separated by the diameter. Anterior eyes in an almost straight line, median only slightly smaller than the lateral, separated by the radius and from the lateral by nearly the diameter.

Femur of palpus long, slender, curved inward, only slightly widened distally. Patella moderately long, curved downward. Ratio of length of femur to that of patella as 11 to 6. Tibia produced into a long apophysis which arises on the mesodorsal angle and curves laterally over the base of the cymbium; the tip is bluntly rounded with the edge minutely dentate. Laterally from the apophysis there is a deep rounded emargination; the dorsolateral angle produced into a blunt tooth. Paracymbium very broad at base, stout and strongly curved. The tail-piece of the embolic division long, slender, and pointed at the tip, which extends beyond the edge of the cymbium. The terminal part of the tail-piece consists of two layers or leaves attached at one side like a partly opened book. The embolus arises directly from the tail-piece in the interior of the bulb; it is a very long, slender style and makes one large flat turn on the ventrolateral side of the bulb.

FEMALE. Length, 1.9 mm. Similar to male in form but stouter. Cephalothorax dull yellow suffused with dusky, legs somewhat lighter than in the male. Posterior eyes in a straight line, the median a little larger than the lateral, separated by the radius and from the lateral by a little more. Anterior eyes in a slightly procurved line; the median small, round, the lateral elon-

gate oval; the median separated by less than the radius and from the lateral by the radius.

The epigynum has the median fovea long and slender, broader in front than behind and overhung in front by a small pale triangular lobe. On each side of the fovea in front there is a shallow furrow which is bounded laterally by a distinct ridge. These ridges curve inward in front.

Described from the type, a male, in the collection of the Museum of Comparative Zoology at Cambridge, Mass. The female specimen preserved with the male is apparently not the specimen whose epigynum was described by Emerton.

Type locality: Terrace, B. C.

British Columbia: Terrace, 1923, 2 ♂, several ♀; Mar., 1933, 2 ♂ (Mrs. Hippisley).

Labrador: Cabot Lake, 1 ♂ (F. W. Waugh).

Washington: Sol Duc Hot Springs, Aug. 12, 1927, 5 ♂ 4 ♀.

Alaska: Admiralty Island, 1933, 6 ♂ 9 ♀ (Sheppard).

DICYMBIUM Menge

Preuss. Spinn. p. 193. 1868

Type: *Dicymbium clavipes* Menge, which equals *Neriene tibialis* Blackwall. Designated by Simon (Ar. Fr. 5: 541. 1884).

That *clavipes* was considered as the type of Menge is indicated by the fact that he refers to the figures of this species in the description of the genus. In 1884 Simon designated *tibialis* (*clavipes*) as the type but in 1894 (Hist. Nat. Ar. 1: 659) he designated *nigrum* (*gracilipes*). His later action was unjustified in view of the earlier designation of *tibialis*.

This genus is distinguished by the form of the cephalothorax, the form of the tibia of the male palpus and the peculiar development of the median apophysis of the genital bulb.

Dicymbium elongatum Emerton

(Figures 25–30)

Lophomma elongatum Emerton. Conn. Acad. Sci. Trans. 6: 44, pl. 10, fig. 2. 1882.

MALE. Length, 2 mm. Cephalothorax dark yellowish brown with darker radiating lines and a dark triangular area in front of the dorsal furrow. Head yellowish with a double median

brownish line extending from between the eyes backward. Cephalothorax viewed from above elongate ovate, evenly rounded on the sides behind, the sides rounded, convergent to the anterior median eyes which are borne on a blunt snout far in advance of the lateral eyes; viewed from the side, ascending rather steeply behind, then nearly flat along the back to the head, then rounded upward to the posterior median eyes; from the posterior median to the anterior median eyes slanting downward in a straight line. Clypeus very high, slightly concave and strongly retreating. Top of the head between the eyes and the median ocular area clothed with hairs directed forward; just back of the anterior median eyes the hairs are directed upward and backward. Sternum and labium dark brown, finely rugose. Sternum produced between the hind coxæ in a truncate inflexed point. Hind coxæ separated by a little more than the diameter. Endites yellow orange, deeply suffused with gray. Legs and palpi yellow, tinged with orange, the coxæ suffused with gray below. Cheliceræ orange yellow, nearly normal in form, slightly divaricate, the upper margin of the furrow armed with 3 or 4 long teeth. Abdomen dark gray.

Posterior eyes in a straight line, equal, the median separated by three times the diameter and from the lateral by 1¼ times the diameter. Anterior eyes in a recurved line, the median borne on the tip of a conical projection of the head, separated from each other by the radius and from the lateral by five times the diameter.

Femur of palpus gradually enlarged distally and curved inward. Patella short, gently convex above. Ratio of length of femur to that of patella as 25 to 11. Tibia short but provided with an extremely large dorsal apophysis which extends over three-fourths the length of the cymbium. The basal part is broad, curved mesally and clothed with hairs, thin and smoothly emarginate mesally, finely dentate at base on the lateral margin and armed with a broad triangular, nearly transparent tooth just before the bend. The apical third is bent sharply backward and outward at an acute angle; it is thinner, destitute of hairs, gently curved, and lies close to the cymbium. Paracymbium short, broad and strongly bent with a deep rounded notch before the tip. Bezel rather small. The mesal side of tegulum conspicuous, strongly chitinized and dark in color. The embolic division lies across the

tip of the bulb. The tail-piece is twisted, its basal part is large and broad, the tip small and twisted. The embolus is coiled spirally in two small turns; at its base there are two processes, a hyaline spine-like one directed towards the tip of the tarsus and a short, black, curved one at the base. The median apophysis extends across the tail-piece as a long, thin, slender, hyaline process. On the opposite side, visible only in the expanded bulb, it bears a stout tooth.

FEMALE. Length 1.6 mm. Similar to the male, but the head is normal and the cephalothorax relatively broader. Posterior eyes in a straight line, the median slightly larger than the lateral, equidistant, separated by three-fourths the diameter of the median. Anterior eyes in a slightly recurved line, the median smaller than the lateral, separated by the radius and from the lateral by a little more than the diameter. The epigynum consists of an oval transverse plate divided in the middle by a narrow fovea entirely occupied by a T-shaped middle lobe.

Type localities: Salem, Boston and Mt. Tom, Mass.

New York: Beaver River Flow, Aug. 8, 1931, 1 ♂; Wawbeek, June 13, 1927, 1 ♂ 2 ♀; Raquette Falls, Aug. 24, 1922, 1 ♂; McLean, May; Ringwood, Tompkins Co., May 20, 1919, 1 ♂ (Dietrich); Prattsburg, July 16, 1926, 1 ♂ 7 ♀; Pinekill, Sullivan Co., May 11, 1922, 1 ♂.

North Carolina: Summit Mt. Michell, Oct. 22, 1923, 2 ♂ 4 ♀.

This species is not related to Lophomma but is very close to the type of Dicymbium.

SCIRITES new genus

Type: *Dicymbius pectinatum* Emerton.

This genus is closely related to Scolopembolus having the same type of embolic division, but the tibia of the male palpus is of a different type, lacking the two teeth present in that genus. The anterior metatarsi are armed with a row of long curved spines.

Scirites pectinatus Emerton

(Figures 31–34)

Dicymbium pectinatum Emerton, Conn. Acad. Sci. Trans. 16: 389, pl. 1, f. 8, 1911.

MALE. Length, 1 mm. Cephalothorax orange yellow strongly

suffused with dusky, darker along the radiating lines and along the margin; viewed from above evenly and broadly rounded on the sides without any constriction at the cervical groove, broadly rounded across the front; viewed from the side, steeply ascending behind to the cervical groove, then more gently to the posterior eyes with a slight depression just in front of the cervical groove. Clypeus slightly convex and slightly protruding. Sternum dark gray, broad, strongly convex, smooth and shining. Endites and coxæ yellow suffused with dusky. Legs orange yellow, patella lighter. Abdomen dark gray, almost black. Metatarsus of first leg armed dorsomesally with a series of seven long strong, outwardly curving spines.

Posterior eyes in a straight line, equal and equidistant, separated by three times the radius. Anterior eyes in a slightly procurved line, the median only slightly smaller than the lateral, separated by the radius and from the lateral by the diameter.

Femur of palpus almost straight. Patella distinctly swollen. Ratio of length of femur to that of patella as 18 to 10. Tibia narrow at base, long, very obliquely truncate with the tarsus so inserted that it stands at nearly a right angle to the tibia; viewed from above broadly lanceolate, narrow at base, slightly curved mesally, bluntly rounded at tip, the dorsolateral margin, thin and incurved, ending laterally in a square point which at certain angles appears as a tooth. Paracymbium very small and very strongly curved. Tegulum protuberant ventrally; the bezel straight, dark gray to black and with the surface thickly and minutely denticulate; a few denticles present in the tegulum. Tail-piece of the embolic division rather long and slender, extending beyond the edge of the tegulum, broadened basally and then narrowed to a minute black point, the embolus. The embolus is protected by a broad, concave, membranous conductor. The median apophysis appears as a delicate, short, flattened process behind the embolus.

Female. Length, 1 mm. Similar to male. The epigynum consists of a convex plate with a rectangular fovea occupied by a light colored median lobe overhung from in front by a thin plate rounded behind. The abdomen extends farther forward over the posterior part of the thorax than usual.

Type locality: Three Mile Island, Lake Winnipesaukee, N. H.

New York: McLean, April 30, 1930, 1 ♂; May 8, 1919, 2 ♂ 2 ♀; May 30, 1919, 1 ♀; May 6, 1920, 1 ♂; Montauk Point, May 24, 1924, 2 ♂ 3 ♀.

SCIRONIS new genus

Type: *Tmeticus tarsalis* Emerton.

This genus is characterized by the peculiar position occupied by the base of the embolic division, in the middle of the tegular ring.

Scironis tarsalis Emerton

(Figures 35–37)

Tmeticus tarsalis Emerton. Conn. Acad. Sci. Trans. 16: 394, pl. 3, fig. 2, 1911.

MALE. Length, 1.5 mm. Cephalothorax dusky yellowish with darker radiating lines; viewed from above, evenly rounded on the sides, gently convergent towards the front, broadly rounded in front; viewed from the side, steeply ascending to the dorsal groove, then gradually rounded to the posterior eyes. Clypeus gently convex and slightly protruding. Sternum dark greenish gray with minute light spots, surface minutely pebbled, rather broad, convex, rounded on the sides convergent behind and produced in a truncated point between the hind coxæ which are separated by two-thirds of the diameter. Labium dark. Endites dusky yellow. Legs and palpi dusky orange yellow. Coxæ below mottled with grayish, narrowly marginated with gray. No tooth on face of chelicera. Abdomen dark greenish gray.

Posterior eyes in a slightly recurved line, equal, and equidistant, separated by a little less than the diameter. Anterior eyes in a straight line, the median smaller than the lateral, separated by less than the radius and from the lateral by the radius. Clypeus is as wide as the median ocular area.

Femur of palpus moderately long and stout, rather strongly curved. Patella short. Ratio of length of femur to that of patella as 12 to 4. Tibia as long as patella, strongly convex dorsally. The dorsal margin opposite the paracymbium thin, the lateral corner square, the front margin with a very small, rounded tooth and laterally with a minute pointed tooth. Paracymbium large, broad, strongly curved, notched before the tip, head round.

The lateral edge of the cymbium folded under forming a very deep groove, the lateral edge, towards the tip produced into an oblique, rounded lobe. The embolus arises at the middle of the tegular ring as an enlarged bulb. It is very long and slender; it first runs to the base of the tarsus then follows the edge of the cymbium around to the lateral side, then curves across the face of the bulb; the tip being very fine. The median apophysis consists of a black, sharp-pointed, slender process near the base of the embolus and serves to hold the first turn of the coiled embolus in position.

Type localities: Fall River, Mass.; Mt. Mansfield, Vt.; Crawford Notch, N. H.

New York: Great Pond, Riverhead, May 23, 1924, 1 ♂; Mt. Whiteface, Sept. 13, 1931, 2 ♂ (Hammer); East Aurora, May 13, 1928, 1 ♂ (Dietrich).

Vermont: Mt. Mansfield, Sept. 26, 1908, 2 ♂ 1 ♀.

Massachusetts: Holliston, Apr. 26, June 24, Oct. 14, 3 ♂.

SINORIA new genus

Type: *Sinoria rapidula* n. sp.

In this genus the tibia of the male palpus has the lateral angle broadly produced into a concave rounded lobe. The embolic division has the tail-piece greatly developed and deeply cleft by a narrow fissure into two parts. The embolus is short.

Sinoria repidula new species

(Figures 38–39)

Male. Length, 1.5 mm. The whole specimen seems to have been faded and the colors are probably not normal. Cephalothorax pale yellowish; viewed from above decidedly broad, rounded on the sides, the sides strongly converging towards the front, rounded across the front, the eyes in profile; viewed from the side, rather high, steeply arched over the back to the eyes, highest back of the posterior median eyes. A median row of four stiff hairs back of the eyes. Clypeus broad, gently concave, nearly vertical. Sternum lightly suffused with gray, endites paler. Cheliceræ with a tooth on the face. Legs and palpi pale yellow. Abdomen light gray.

Posterior eyes in a gently recurved line, equal, the median separated by the radius and from the lateral by a little more. Anterior eyes in a straight line, the median smaller than the lateral, separated by less than the radius and from the lateral by the radius.

Femur of palpus rather slender, a little thicker distally. Patella short. Ratio of length of femur to that of patella as 27 to 18 Tibia short, obconic, produced dorsally into a large, thin, smooth, broad, concave process or lobe,

rounded at apex and on the mesal side, lateral margin concave. Paracymbium strongly curved, widened in the distal third, curved and pointed at tip without a distinct notch. The tail-piece of the embolic division is a very large double structure occupying the greater part of the bulb; the two sides of the tail-piece are folded together so as to leave a narrow groove between; the lateral half has the inner margin thickened and black so as to be easily mistaken for a long black process; the embolus is short and attached to the distal angle of the mesal half; the tip bears a small tooth on each side, the duct opens in the lower one.

Holotype, male, Bocas del Toro, Panama. F. R. Swift, collector.

SITALCAS new genus

Type: *Sitalcas ruralis* n. sp.

In some respects this genus is related to Gnathonarium but it is distinguished by the form of the embolic division as a whole and by the course followed by the long, slender embolus.

Sitalcas ruralis new species

(Figures 40–42)

MALE. Length, 1 mm. Cephalothorax orange yellow lightly suffused with gray, narrowly margined with gray; viewed from above broadly rounded, the sides convergent toward the front, the eyes in profile; viewed from the side ascending in a straight line behind and then broadly arched over the back to the eyes, highest behind the eyes; the eyes on the anterior declivity. Sternum large, smooth, convex, light gray over pale orange. Endites pale orange. Legs pale orange yellow. Abdomen light gray.

Posterior eyes in a straight line, the median smaller than the lateral, equidistant, separated by the diameter. Anterior eyes in a straight line, the median much smaller than the lateral, separated by the radius and from the lateral by the diameter.

Femur of palpus moderately long and slender, slightly curved inward. Patella short. Ratio of length of femur to that of patella as 14 to 5. Tibia with the dorsal margin thin and smoothly rounded, the lateral excavation shallow and evenly rounded. Paracymbium wide at base, then slender and curved and enlarged at tip. Tail-piece of the embolic division transverse, laterally bluntly rounded; basally it is armed with an irregular protuberance and gives rise to a very long, style-like embolus which makes a loop across the face of the bulb, passes around back of the greatly enlarged median apophysis and the tip lies in a groove in a short process arising from the outer face of the median apophysis.

FEMALE. Length 1.1 mm. Similar to male. The epigynum a quadrate plate with the fovea transverse, bounded in front by an overhanging lobe, slightly notched in the middle.

Holotype, male; allotype, female and one male paratype.

Ithaca (Six-mile Creek), N. Y., April 24, 1926 (Seeley and Fletcher).

SCIASTES new genus

Type: *Tmeticus truncatus* Emerton.

In this genus we place a group of species in which the tibia of the male palpus is not produced over the base of the cymbium or only slightly so. The embolic division is very simple, the tail-piece being a nearly flat, elongate plate that gives rise directly to a short pointed embolus. The most aberrant member of the group is *terrestris,* but we place it here because of the form of the tibia.

Sciastes acuminatus Emerton

(Figures 43–45)

Tmeticus acuminatus Emerton. Am. Mus. Nat. Hist. Bul. 32: 256, pl. 48, fig. 3. 1913.

MALE. Length, about 1 mm. (abdomen off). Cephalothorax dull honey-yellowish, viewed from above rather broad across the middle, the sides converging in nearly straight lines towards the front, rounded across the front; viewed from the side, rather steeply ascending behind, then very gently arched over the back to the posterior eyes. Clypeus nearly straight, slanting forward. Sternum light gray over yellow, triangular with the sides somewhat rounded towards the front. In the other specimen the sternum is much narrower with the sides straight, a condition probably due to shrinkage. Endites paler than sternum. Cheliceræ rather weak, retreating, without a tooth on face. Legs and palpi dull yellowish. Abdomen gray.

Posterior eyes in a procurved line, separated by less than the diameter. Anterior eyes in a slightly recurved line, the median smaller than the lateral, all very close together.

Femur of palpus nearly straight, fairly thick and compressed. Patella short. Ratio of length of femur to that of patella as 11 to 4; tibia on ventral side 4, on dorsal, 6. Tibia dorsally produced forward in a broad, thin, truncate process, the anterior margin of which is distinctly concave and the corners angulate, the inner one more acute. Paracymbium very small and strongly curved. The embolic division consists of a thin, flat plate with a short curved tooth on the anterior edge, through which the ejaculatory duct opens.

Type locality: Lakehurst, N. J.
New Jersey: Lakehurst, May 1, 1912, 2 ♂, the types.
Massachusetts: Hammonds Pond, May 1, 1906, 1 ♂ (Bryant).

Sciastes concavus Emerton

(Figures 46–47)

Tmeticus concavus Emerton. Conn. Acad. Sci. Trans. 6: 57, pl. 17, fig. 3. 1882.

Œdothorax concavus Crosby. Phila. Acad. Nat. Sci. Proc. 1905, p. 311.

MALE. Length 1.8. Cephalothorax yellow orange, viewed from above, evenly rounded on the sides to the cervical groove and then converging towards the front, evenly and broadly rounded across the front; viewed from the side rather low, gently ascending behind, then very gently rounded over the top to the posterior median eyes. A median row of 5 long hairs directed forward. Clypeus nearly straight and slightly protruding. Sternum yellow-orange suffused with gray, convex, the sides crenulate, somewhat produced between the hind coxæ. Labium and endites lighter. Legs yellow-orange. Abdomen light gray.

Posterior eyes in a straight line, equal, separated by three-fourths the diameter and from the lateral by the radius. Anterior eyes in a straight line, the median smaller than the lateral, separated by two-thirds the diameter and a little farther from the lateral.

Femur of palpus moderately long, gradually widened distally, curved inward. Patella short and broad, convex above. Ratio length of femur to that of patella as 24 to 8. Tibia obconic, the margin unmodified by processes or emarginations. The paracymbium extraordinarily developed, the basal part very wide and concave, armed at base with two small hairs, the terminal part very broad and thin, separated from the basal part by a thin ridge armed with two or three small hairs. The tail-piece of the embolic division, broad and flat, the tip turned inward at nearly a right angle; the ejaculatory duct opens on it through a short pointed embolus.

Type localities: Clarendon Hills near Boston, Mass., and New Haven, Conn.

Massachusetts: Readville, Nov. 6, 1913, 2 ♂ (Emerton); 1908, 23 ♂ (Emerton); Blue Hills, Nov. 28, 1914, 1 ♂ (Emerton); Monponset, June 12, 1915, 1 ♂ (Emerton); Hyde Park, May 14, 1875, ♂ (type); Ipswich, May 18, 1919, 2 ♂.

New York: Raquette Lake, June 11, 1927, 4 ♂; Mendon Ponds, Monroe Co., May 18, 1930; Cinnamon Lake, Schuyler Co., June 10, 1934, 1 ♂.

Quebec: Ile d'Alma, Lac St-Jean, July 28, 1934, 1 ♂ 2 ♀.

Vermont: Mt. Mansfield, July 5, 1935, 2 ♂.

Sciastes microtarsus Emerton

(Figures 48–49a)

Tmeticus microtarsus Emerton. Conn. Acad. Sci. Trans. 6: 57, pl 17, fig. 4. 1882.

Œdothorax microtarsus Crosby. Phila. Acad. Nat. Sci. Proc. 1905, p. 311.

MALE. Length, 1.5 mm. Cephalothorax dusky yellowish, darker at the margin with darker radiating lines, eye area black; viewed from above evenly rounded, convergent toward the front, truncated in front, the eyes not occupying the whole width of the head. Cephalothorax viewed from the side steeply ascending to the cervical groove, then rounded evenly over the head to the posterior eyes, highest just behind the posterior eyes. Clypeus straight and vertical. Sternum gray, pebbled with yellowish, rather long, gently rounded on the sides and narrowly produced between the hind coxæ which are separated by a little less than the diameter. Endites dusky orange-yellow. No tooth on face of chelicera. Legs and palpi pale orange-yellow. Abdomen greenish gray, lighter below.

Posterior eyes in a straight line, equal, the median separated by the radius and a little farther from the lateral. Anterior eyes in a slightly recurved line, median smaller than the lateral, oval, convergent and subcontiguous below, almost touching the lateral. Clypeus only a little more than half as wide as the ocular area.

Femur of palpus rather short and stout, a little widened distally and rather strongly bent. Patella short and widened distally. Ratio of length of femur to that of patella as 18 to 7. Tibia longer than broad, evenly widened distally without an apophysis but the

margin slightly thickened at the point where it usually occurs. Cymbium small. Paracymbium a broad plate bent at a right angle with a sharp triangular notch before the tip, base swollen and bearing a few hairs. Subtegulum narrow; bezel with a sharp tooth on the edge. The tail-piece of the embolic division consists of a broad, flat, semicircular plate which is pointed at the ventral corner and has the embolus attached to it by a stalk. The embolus is very small, broadly pyriform and ends in a sharp black point which is strongly curved to the side. The median apophysis curves around the embolus and ends in a minute black point.

FEMALE. Length, 1.6 mm. Colored like the male. The anterior median eyes more nearly round, subcontiguous, but separated from the lateral by the radius. Epigynum is a strongly chitinized convex plate produced to a blunt point behind, gently emarginate on the sides.

Type locality: Mt. Washington, N. H., in moss under the highest trees.

New York: Mt. Whiteface, Essex Co., Aug. 22, 1916, 3 ♂ 5 ♀; Oct. 21, 1934, 2 ♂ 1 ♀.

Colorado: Pingree Park, Larimer Co., Aug. 20, 1924, 2 ♂.

Sciastes simplex Chamberlin

(Figures 50–53)

Grammonota simplex Chamberlin. Ent. Soc. Am. An. 12: 250, pl. 18, fig. 1, 2. 1919.

MALE. Length, 2 mm. Cephalothorax dusky orange-yellow, viewed from above evenly rounded, convergent towards the front, rounded on the frontal angles, straight across in front; viewed from the side posterior declivity steeply ascending, then gradually rounded over to the posterior eyes. Clypeus straight and almost vertical.

Sternum yellow suffused with dusky, darker at margin, broad, convex, rounded on the sides, produced in a truncate point between the hind coxæ, which are separated by a little less than the diameter. Labium and endites dusky orange-yellow. Legs and palpi yellowish. Abdomen grayish black.

Posterior eyes in a straight line, equal, equidistant, separated by the diameter. Anterior eyes in a very slightly recurved line,

the median smaller than the lateral, separated by a little less than the radius and from the lateral by a little more. Clypeus as wide as median ocular area. No tooth on face of chelicera.

Femur of palpus rather slender, moderately long, rather strongly curved. Patella moderately convex above. Ratio of length of femur to that of patella as 20 to 8. Tibia longer than patella, only moderately enlarged distally, dorsal margin thin, evenly rounded without teeth or apophysis. Paracymbium very large, nearly flat, broadly rounded on the side toward the tip of the palpus, straight on the mesal side where it is opposed by a prolongation of the base of the cymbium, with a broad rounded notch on the side next to the base, armed at base with three short hairs. Bezel high and produced into a rounded apophysis. Tail-piece of the embolic division long, rounded at tip and extending to the edge of the cymbium. At the base on the ventral side it gives rise directly to the black, sharp, pointed style-like embolus, the tip of which lies next to the apophysis on the bezel. The median apophysis appears as a broad, blackish rounded lobe with a serrate edge lying back under the tip of the cymbium.

FEMALE. Length, 2 mm. Similar to the male. Posterior eyes in a straight line, the median a little larger than the lateral, equidistant, separated by a little less than the diameter. Anterior eyes in a straight line, the median smaller than the lateral, separated by the radius and a little farther from the lateral. The epigynum is a transverse plate overlain in the middle by a transparent plate which projects a little back of the margin.

Described from 1 ♂ 1 ♀, paratypes, Chalk Creek, Uintah Mts., 7500 ft., Utah.

Colorado: Pingree Park, Aug. 20, 1923, 1 ♀ (sifted from moss).

Idaho: Emigration Canyon, Aug. 29, 1928, 2 ♂ (Gertsch).

Wyoming: Yellowstone Park, Grand Canyon, Aug. 30, 1927, 3 ♂ 7 ♀.

British Columbia: Terrace, June 1–10, 1931, 1 ♂ (Hippisley).

Utah: Teacup Lake, Uintah Mts., Sept. 5, 1931, 2 ♂.

Sciastes terrestris Emerton

(Figures 54–56)

Tmeticus terrestris Emerton, Conn. Acad. Sci. Trans. 6: 57, pl. 17, fig. 6. 1882.

Œdothorax terrestris Crosby, Phila. Acad. Nat. Sci. Proc. 1905, p. 313.

Microneta clavata Emerton, Can. Ent. 49: 265, f. 17. 1917. (Types compared.)

MALE. Length, 1.5 mm. Cephalothorax dusky orange; viewed from above rather narrow, evenly rounded on the sides, slightly convergent towards the front, broadly rounded in front; viewed from the side rather steeply ascending behind, then evenly rounded over to the eyes. Clypeus slightly convex and protruding. Sternum orange-yellow, convex, rounded on the sides, convergent behind and produced in a broad truncated point between the hind coxæ which are separated by the diameter. Labium and endites same color as sternum. No tooth on face of chelicera. Legs and palpi yellowish orange. Abdomen yellowish gray.

Posterior eyes in a straight line, equal, equidistant, separated by a little more than the diameter. Anterior eyes in a straight line, the median smaller than the lateral, separated by a little less than the diameter and from the lateral by three times the radius. Clypeus about as wide as the median ocular area.

Femur of palpus moderately long and slender, slightly curved. Patella short, rather strongly arched above. Ratio of length of femur to that of patella as 15 to 5. Tibia a little longer than patella, widened distally but not produced into teeth; armed back of the margin by a regular, transverse row of long hairs. The paracymbium very strongly curved, with three rounded teeth on the inner margin. Tegulum strongly developed, a distinct tooth on the bezel. Tail-piece of the embolic division very large, quadrate, the tip greatly narrowed, pointed and extending to the edge of the cymbium. The lateral corner farthest from the cymbium black, sharply angulate; at the opposite angle there is a longer pointed process; behind this arises the rather elongate embolus. The median apophysis appears as a rather long, slightly curved black process back of the embolus.

FEMALE. Length, 1.5 mm. Similar to male in form and color. The epigynum is a transverse, convex plate with a very large oval opening in the middle. Behind the opening there is a transverse middle lobe. Female described from a specimen from Roslyn, New York.

Type localities: Mt. Tom, Holyoke and Salem, Massachusetts.

Massachusetts: Blue Hills, Milton, near Boston, Oct. 8, 1904, 1 ♂ 1 ♀; Nov. 23, 1914, 1 ♂; Nov. 28, 1914, 1 ♂ 1 ♀ (Emerton); Clarendon Hills, Nov. 12, 1908, 1 ♂ (Bryant); Hammonds Pond, Nov. 8, 1904, 1 ♂ (Bryant); Ipswich, May 18, 1919, 2 ♂ (Emerton).

New York: Roslyn, 3 ♂ 2 ♀ (Banks); Coram, April 3, 1931, 1 ♂; Poughkeepsie, April 19, 1931, 1 ♂; Ithaca, May 16, 1926, 1 ♂ 2 ♀ (Seeley & Fletcher); Wilmington Notch, Aug., 1916, 1 ♂, the type of *Microneta clavata* Em., not the ♀; Fish Pond Creek, Franklin Co., Sept. 6, 1931, 1 ♂ 3 ♀.

Ontario: Toronto, April 9, 1934, 3 ♂ (Dymond).

Michigan: Albion, April 12, 1933, 3 ♂ 2 ♀; Dec. 18, 1933, 1 ♂ (Chickering).

Sciastes truncatus Emerton

(Figures 57–59)

Tmeticus truncatus Emerton. Conn. Acad. Sci. Trans. 6: 57, pl. 17, fig. 5. 1882.

Œdothorax truncatus Crosby. Phila. Acad. Nat. Sci. Proc. 1905, p. 313.

Gongylidium truncatus Emerton. Royal Can. Inst. Trans. 12: 316. 1919.

Male. Length, 2 mm. Cephalothorax orange-yellow, viewed from above rather long, rounded on the sides, slightly convergent towards the front, nearly straight across the front, the eyes occupying the whole width; viewed from the side, steeply ascending behind, then more gradually ascending to the back of the head, rounded over the top of the head. Clypeus almost vertical and slightly convex. Sternum dusky orange, darker at the margin, broad and convex, rounded on the sides, tapering behind and produced in a blunt point between the hind coxæ which are separated by a little less than the diameter. Labium dusky. Endites dusky orange. Legs and palpi bright orange-yellow. Legs long and somewhat hairy. Abdomen grayish yellow with narrow indistinct transverse light lines. Cheliceræ rather large, somewhat divaricate.

Posterior eyes in a straight line, equal, the median separated

by a little less than the diameter and from the lateral by the diameter. Anterior eyes in a slightly recurved line, the median smaller than the lateral, subcontiguous, separated from the lateral by the diameter. Clypeus as wide as median ocular area.

Femur of palpus rather stout, moderately long and moderately curved. Patella rather long and almost straight. Ratio of length of femur to that of patella as 25 to 10. Tibia about as long as patella, widened distally and produced dorsally into a thin, wide, squarely truncated lobe; dorsolateral angle with a deep, evenly rounded notch. Paracymbium very large, surrounding the base of the bulb, and reaching to the base of the cymbium on the opposite side where it is armed with two long, slender hairs. The extreme base armed with five small stiff hairs. The base, separated from the main part by a deep cleft. Bezel rather low, rounded on the edge. Tail-piece of the embolic division short and broad and rounded at tip with a finger-like process on the side next to the cymbium. The embolus arises directly from it and is obliquely narrowed, rather short and ends in a sharp point.

FEMALE. Length, 2 mm. Similar to the male, the legs more distinctly hairy, the cheliceræ robust but not so divaricate. Posterior eyes in a straight line, equal, equidistant, separated by three-fifths of the diameter. Anterior eyes in a very slightly recurved line, the median smaller than the lateral, separated by less than the radius and from the lateral by a little less than the diameter. The epigynum is a transverse oval plate notched behind by a truncate triangular fovea, filled by a pale yellow, smooth, convex, middle lobe.

Type locality: Mt. Washington, N. H., in moss under the highest trees.

Maine: Molunkus Pond, Aug. 25, 1925, 1 ♂; Presque Isle, Aug. 26, 1925, 3 ♂ 3 ♀.

Massachusetts: Carlisle Pines, Oct. 26, 1907, 1 ♂ (Bryant).

New York: Artist Brook, June 11, 1933, 1 ♂; Auger Pond, Essex Co., Nov. 16, 1916, 1 ♂; Black Brook, June 10, 1933, 1 ♂; Brant Lake, Oct. 3, 1931, 1 ♂; Cadyville, June 9, 1933, 1 ♂ 1 ♀; Mt. Marcy, Aug. 27, 1930, 2 ♂; Mt. Whiteface, Essex Co., Aug. 1916, 3 ♂; Aug. 25, 1921, 2 ♂; Wawbeek, Oct. 22, 1934, 4 ♂ 4 ♀; Peru, Oct. 22, 1934, 1 ♂.

Quebec: Bagotville, July 26, 1934, 1 ♂ 2 ♀.
British Columbia: Terrace, March, 1933, 1 ♂ 1 ♀ (Hippisley).
Alaska: Admiralty Island, 1933, 1 ♂ 6 ♀ (Sheppard).

Sciastes ursinus new species

(Figures 60–61)

Male. Length, 1.4 mm. In the series of specimens before us there is great variation in the depth of coloring. The following description is from the best colored male. Cephalothorax dull chestnut brown with darker radiating lines and a dark patch on the back of the head connected with the eyes by dark lines; viewed from above evenly rounded on the sides with scarcely any constriction at the cervical groove, rounded across the front; viewed from the side, steeply ascending behind, then more gradually, gently rounded over the head. Clypeus concave below the eyes, then straight and slightly protruding. Sternum nearly black, with minute yellowish dots. Endites dull yellowish suffused with dusky except at tip. Legs dull yellow. Abdomen nearly black.

Posterior eyes in a straight line, equal and equidistant, separated by the diameter. Anterior eyes in a straight line, the median smaller than the lateral, equidistant, separated by the radius.

Femur of palpus nearly straight. Patella short. Ratio of length of femur to that of patella as 18 to 7. Tibia short, obconic, the dorsal margin squarely truncate, the edge black, minutely dentate; the lateral margin thin, smoothly rounded, the outer angle armed with three long spines. Paracymbium large, strongly curved, only slightly hooked at tip. The embolic division roughly triangular with the tail-piece at the lateral basal angle, the short nipple-like embolus at the apex and with the mesal angle sharply bent and produced into a fan-shaped process the outer edge of which is thickened like the ray in a fish's fin. The tail-piece is broad and ends in a rounded point; it is crossed diagonally by a ridge which continues to form the rounded tip that bears the short black nipple-like embolus.

Holotype, male, Longmire, Wash. Aug. 22, 1927, 3 male paratypes with same data.

Sciastes vicosanus new species

(Figures 62–64)

Male. Length, 1.1 mm. Cephalothorax clear pale orange yellow with a median row of 4 hairs back of the eyes; viewed from above rather broad, evenly rounded on the sides without any constriction whatever at the cervical groove, broadly rounded across the front; the anterior eyes in profile; viewed from the side, steeply ascending behind to the cervical groove and then more gradually to the eyes, very gently arched back of the eyes. Clypeus straight and nearly vertical. Sternum rather broad, yellow, slightly suffused with

dusky. Endites slightly brownish. Legs pale yellow. Chelicera armed with a lateral row of three teeth, a blunt tooth on the face. Abdomen pale, nearly white.

Posterior eyes in very slightly recurved line, equal and equidistant, separated by less than the radius. Anterior eyes in a slightly recurved line, the median smaller than the lateral, subcontiguous, a little farther from the lateral.

Femur of palpus moderately stout, slightly thicker distally, curved inward, armed ventrolaterally with a row of 3 stiff hairs. Patella short, cylindrical. Ratio of length of femur to that of patella as 17 to 5. Tibia obconic, the dorsal margin very thin and depressed transversely, excavated, the edge smoothly rounded, back of the excavation there is a secondary margin which is nearly straight. Paracymbium relatively very large, angulate mesally, the tip broadly pointed, the notch very deep. Tail-piece of the embolic division broad and nearly flat, rounded at tip with a broad projection towards the edge of the cymbium. The embolus very small, thin and spirally arising just under the edge of the base of the tail-piece where there is a blackish lump bearing two minute teeth.

FEMALE. Length, 1.1 mm. Similar to the male in form and color. Teeth on the outer edge and face of cheliceræ lacking. The epigynum nearly flat with the openings in the posterior margin; the receptacles ovate, separated by about half the diameter.

Holotype male, allotype female. Viçosa, Minas Gerais, Brazil, July 6, 1933, also ♂ and ♀ paratypes. E. J. Hambleton, collector.

GNATHONAROIDES new genus

Type: *Arœoncus pedalis* Emerton.

This genus is closely related to Gnathonarium in the structure of the genital bulb but differs from it in the form of the tibial armature; this process is long, nearly straight and sharp-pointed.

Gnathonaroides pedalis Emerton

(Figures 65–66)

Arœoncus pedalis Emerton. Can. Ent. 55: 239, fig. 2. 1923.

MALE. Length, 1.3 mm. Cephalothorax light yellowish, the extreme margin blackish; viewed from above, rather broad, evenly rounded on the sides to the eyes, broadly rounded in front; viewed from the side, gently rounded over the posterior declivity to the cervical groove, then gently and broadly curved over to the posterior eyes. Highest part back of the eyes. Clypeus almost straight and very slightly protruding. Sternum pale greenish gray, strongly convex, evenly rounded on the sides, produced in

a truncated point between the hind coxæ which are separated by the diameter. Labium and endites yellowish. Two small setigerous tubercles on the face of the chelicera. Legs and palpi nearly white. Abdomen greenish gray.

Posterior eyes in a straight line, equal, the median separated by the diameter and a little farther from the lateral. Anterior eyes in a straight line, the median much smaller than the lateral, the median separated by the radius and from the lateral by a little more than the diameter. Clypeus about as wide as median ocular area. A long median hair on clypeus and a shorter one on each side just below and to the side of the anterior median eyes.

Femur of palpus moderately long, rather strongly curved and widened distally. Patella rather short and evenly rounded above. Ratio of length of femur to that of patella as 16 to 7. Tibia a little shorter than patella, widened distally and armed with a very long, basally stout and apically slender, incurved, dorsal apophysis. Lateral margin of the cymbium with a broad rounded lobe. The paracymbium moderately slender and very strongly curved; the base obliquely truncate and corners produced as sharp points; the tip is widened and twisted half-way around, armed at base with a longitudinal row of 4 stiff hairs. The bezel is high, narrow, and roundly truncate at tip. The tail-piece of the embolic division lanceolate with its margin parallel with that of the cymbium; the tip of the tail-piece is directed toward the tip of the cymbium; on the side away from the cymbium it bears a small rounded lobe. The embolus arises at the extreme base of the tarsus and is very long and slender; it makes an S-shaped loop across the face of the genital bulb and the very fine tip lies near the bezel. The median apophysis consists of a long, erect process, basally stout and reddish, apically more slender and black, and ending in a very fine, spirally twisted tip. At the base of the apophysis is a small, erect, round tooth. The conductor is a prominent, lanceolate process somewhat twisted and with a sharp beak-like tip.

Type locality: Dauphin, Manitoba.

New York: Altamont, April 12, 1924, 8 ♂; Mountain Lake, Fulton Co., April 26, 1923, 1 ♂.

SISYRBE new genus

Type: *Tmeticus rusticus* Banks.

We find it necessary to establish a new genus for this species because it seems to be unrelated to any of the Erigoneæ known to us either in America or Europe. It is characterized by the peculiar form of the paracymbium, the deeply incised cymbium, the remarkable length of the embolus and its peculiar course. Only the unique type is known.

Sisyrbe rustica Banks

(Figures 67–68)

Tmeticus rusticus Banks. Phila. Acad. Nat. Sci. Proc. 1892, p. 39, pl. 2, fig. 17.

Œdothorax rusticus Crosby. Phila. Acad. Nat. Sci. Proc. 1905, p. 313.

Tmeticus rusticus Banks. Phila. Acad. Nat. Sci. Proc. 1916, p. 74, pl. 10, fig. 10.

MALE. Length, 1.5 mm. Cephalothorax evenly and broadly rounded on the sides, abruptly constricted at the cervical groove, broadly rounded across the front; viewed from the side, rather low, moderately ascending in a nearly straight line to the cervical groove and then gently rounded over the head to the posterior eyes. Clypeus straight and nearly vertical. Sternum rather broad, strongly convex. Endites lighter. Legs orange-yellow. Abdomen gray.

Posterior eyes in a straight line, equal, and equidistant, separated by the diameter. Anterior eyes in a very slightly procurved line, the median only slightly smaller than the lateral, equidistant, separated by a little less than the diameter.

Tibia short, viewed from above diagonally quadrate, the angles rounded, the lateral angle lies over the tip of the dorsal branch of the paracymbium. Paracymbium extraordinarily developed, consisting of a broad, thin, triangular basal part which gives rise to two branches, the tip of the first lies under the lateral margin of the tibia, the other branch is very much larger and longer and ends in a broadly pointed outer angle and a deeply notched and hooked inner angle. The cymbium is very deeply notched on both sides before the middle, the mesal notch is occupied by the tip of the tail-piece of the embolic division. The tail-piece of the embolic division rather stout and dumbbell-shaped; it gives rise

within the bulb to a very long, slender, styliform embolus which lies in a flat coil of about one and one-half turns on the side of the tip of the bulb.

Type locality: Buttermilk Creek, Ithaca, N. Y.

Redescribed from the type.

SCOTOUSSA new genus

Type: *Tmeticus bidentata* Emerton.

This genus is distinguished by the form of the embolic division of the male palpus which bears a long ventral branch or process. The dorsal margin of the tibia has a shallow, rounded notch.

Scotoussa bidentata Emerton

(Figures 69–71)

Tmeticus bidentatus Emerton. Conn. Acad. Sci. Trans. 6: 56, pl. 17, fig. 2, 1882.

Œdothorax bidentatus Crosby. Phila. Acad. Nat. Sci. Proc. 1905, p. 310.

Tmeticus bidentatus Emerton. Conn. Acad. Sci. Trans. 14, pl. 4, fig. 6, 1909. (Figure of epigynum of another species.)

Male. Length, 1.5 mm. Cephalothorax orange-yellow, lightly dusted with gray; viewed from above rather broad, rounded on the sides, not constricted at the cervical groove, convergent towards the front, rounded in front; viewed from the side, rather steeply ascending behind, nearly flat on top, feebly depressed at the cervical groove, gently rounded over the head to the posterior eyes, highest just behind the eyes. Clypeus straight and nearly vertical, a little narrower than the median ocular area. Sternum and labium greenish gray over yellow, endites orange-yellow. Sternum rather long, gradually narrowed to the hind coxæ, then abruptly narrowed to a slender piece which separates the hind coxæ by less than the diameter. Legs and palpi pale yellowish. Abdomen gray. Epigastric plates pale yellowish, finely striate.

Posterior eyes in a straight line, the median separated by a little less than the diameter and from the lateral by the radius. Anterior eyes in a gently recurved line, the median smaller than the lateral, subcontiguous and separated from the lateral by the radius.

Femur of palpus long, slender, thicker distally and distinctly curved inward. Patella short, only a little longer than broad. Ratio of length of femur to that of patella as 12 to 4. Tibia in a full back-view shows a broad, square-tipped process and a smaller and shorter acute one on the side next to the paracymbium, separated by a small rounded notch. To show the two teeth as Emerton has figured them, it must be viewed from far over on the side. Paracymbium strongly curved with a sharp recurved hook at tip and armed at the base with a row of three stiff hairs. The embolic division consists of a rather thick, round-pointed tail-piece, the tip of which is much narrower than the main part and when viewed from the side appears notched below. The terminal part of the embolic division arises directly from the tail-piece from which it is separated by a distinct constriction; it is rather broad and thin, narrower at base and widened distally; it is arched upward and concave below, the surface marked with three strong radiating ridges, each ridge continued at the tip to form a sharp point. The outer (ventral) point contains the ejaculatory duct and bears a rounded lobe beneath it, the middle point is hyaline, and the inner point is stouter and black. At the base of the terminal part of the embolic division there is a rather long, stout, black, curved horn.

FEMALE. Length, 1.8 mm. Similar to the male in form and color. Epigynum when cleared is seen to consist of two lobes; the anterior lobe extends back over the posterior lobe so that the latter appears as a narrow transverse plate. The hind margin of the anterior lobe is rounded in the middle and gently concave on the sides. When not cleared and viewed directly from below the posterior lobe is invisible and the anterior lobe appears more pointed behind. There seems to be a slight depression on the face of the anterior lobe.

The female is described from a series of specimens taken with males on Mt. Whiteface, N. Y. Emerton's figure of the epigynum (1909) is apparently from another species.

Type locality: Mt. Washington, N. H.

Quebec: Bagotville, July 26, 1934, 10 ♂; Herbertville, July 29, 1934, 8 ♀.

Maine: Presque Isle, Aug. 26, 1925. 3 ♂ 3 ♀.

New Hampshire: Base Station, Mt. Washington, Aug. 18, 1925, 9 ♀; under highest trees, July 5, 1925, 1 ♂ 4 ♀.

New York: Mt. Whiteface, Essex Co., Aug. 22, 1916, 17 ♂ 16 ♀; Aug. 25, 1921, 1 ♂ 6 ♀; Oct. 21, 1934, 5 ♂ 18 ♀; Mt. MacIntyre, Essex Co., July 1, 1923, 4 ♂ 1 ♀; Mt. Marcy, Aug. 27, 1930, 7 ♂ 11 ♀; Lake Tear, Sept. 14, 1922, 2 ♂ 3 ♀; Avalanche Lake, July 24, 1925, 2 ♂; Uphill Brook and Opalescent River, Essex Co., July 1918, 6 ♀; Chapel Pond, June 27, 1923, 1 ♂ 3 ♀; Artist's Brook, Essex Co., June 11, 1933, 2 ♂; Oct. 20, 1934, 14 ♂ 15 ♀; Sept. 7, 1931, 2 ♂ 2 ♀; Slide Mt., Ulster Co., June 24, 1934, 1 ♂ 4 ♀.

Vermont: Top of Mt. Mansfield, June 14, 1927, 1 ♂ 1 ♀.

Alberta: Sulfur Mt., Banff, Aug. 22, 1927, 2 ♂ 2 ♀.

This species has also been recorded by Emerton from Vermont: Mt. Mansfield; Maine: Mt. Katahdin; Fort Fairfield; New Hampshire: Sandwich Mts.; Labrador: Battle Harbor; Alberta: Banff; Jasper.

SCYLETRIA new genus

Type: *Scyletria inflatus* new species.

In this genus we place two species because of the similarity in the structure of the embolic division of the male palpus. There is a sharp turn between the tail-piece and the base of the flattened embolus. The tibia has a notch leaving the two processes of about equal length. The two species included in this genus can be separated by the form of the tibia of the male palpus as shown in the figures.

Scyletria inflata new species

(Figures 72–74)

MALE. Length, 1.6 mm. Cephalothorax dusky over dull yellow, darker at the margin; viewed from above evenly and broadly rounded on the sides, rather abruptly convergent toward the front, eyes in profile; viewed from the side, rather steeply ascending behind to the cervical groove where there is a rather broad depression, gently rounded over the head to the posterior median eyes. Median ocular area sloping steeply downward. Clypeus nearly vertical, concave. Sternum dark gray, nearly black. Labium gray, endites dusky orange, lighter distally. Legs pale yellow. Abdomen dark gray, almost black.

Posterior eyes in a very slightly recurved line, equal and equidistant, separated by the diameter. Anterior eyes in a straight line, the median slightly smaller than the lateral, separated by a little less than the radius and from the lateral by a little less.

Femur of palpus long, slender, curved inward. Patella short and rather

thick. Ratio of length of femur to that of patella 21 to 7. Tibia dark, contrasting in color with the femur and patella, strongly compressed laterally. Viewed from the mesal side strongly convex above the distal margin with a broad, rounded lobe; the dorsolateral process viewed from this angle appears to end in two teeth; the upper nearly straight and stouter, the lower one stout at base, slender at tip, upturned. Tibia viewed from above shows the broad, rounded lobe on the mesal side with a shallow rounded emargination between it and the dorsolateral process, armed in the middle of the excavation with a stout, triangular tooth. In this view only the upper tooth of the dorsolateral process is visible. The lateral margin of the tibia has a very deep, rounded excavation. Paracymbium slender at base, thick and heavily chitinized, the nearly flat, terminal portion roughly triangular, the tip very broad, divided into two lobes by a deep, oblique rounded notch. The tail-piece of the embolic division is triangular with the proximal angle acute, rounded next to the edge of the cymbium. It gives rise to a broad, thin embolus which is folded lengthwise on itself, the two parts being nearly parallel. The duct opens in the lateral corner of the ventral layer.

Holotype, male. Raquette Lake, N. Y., June 11, 1927.
North Carolina: Summit of Mt. Mitchell, Oct. 12, 1923, 3 ♂.

Scyletria jona new species

(Figures 75–76)

MALE. Length, 1.1 mm. Cephalothorax pale orange yellow slightly darker towards the head; viewed from above evenly and broadly rounded on the sides without any constriction at the cervical groove, broadly rounded across the front; viewed from the side broadly and evenly rounded over the back to the posterior median eyes. Clypeus very slightly concave and slightly retreating. Sternum broad, strongly convex, pale yellow. Labium and endites slightly darker. Cheliceræ armed with a distinct tooth on face. Legs and palpi pale yellow. Abdomen dull yellowish white.

Posterior eyes in a straight line, equal, the median, oval, separated by the short diameter, the same distance from the lateral. Anterior eyes in a very slightly recurved line, the median very much smaller than the lateral, subcontiguous, separated from the lateral by the radius.

Femur and patella of palpus normal. Ratio of length of femur to that of patella as 15 to 5. Tibia darker than patella, strongly compressed and widened ventrodorsally. Viewed from the mesal side evenly convex above and below, with two large blunt teeth above, the distal margin concave, with a broad, triangular tooth in the middle, dorsally the tibia is produced into a broad, oblique process which is separated into two parts by a deep notch the sides of which are parallel. The paracymbium is extraordinarily developed, the terminal part quadrate with the mesal angle acutely produced and the tip with a very broad, rounded hook. The tail-piece of the embolic division is represented by a triangular plate the lateral edge of which is rolled up

to form a rounded ridge. Laterally from this ridge, and separated from it by a deep furrow, is another parallel ridge which ends in a sharp point. The embolus itself arises back of these ridges and is short, rather stout, curved and ends in a black point. The median apophysis appears as a broad, quadrate plate.

Holotype, male. Ithaca, N. Y., May 17, 1924, found in stomach of brook trout by H. J. Pack.

SCYLACEUS new genus

Type: *Tmeticus pallidus* Emerton.

Here we place two species in which the tibia of the male palpus has a rather long process on the dorsomesal angle. The embolic division has an elongate tail-piece. In *pallidus* the embolus is long and slender while in *obtusus* it is shorter. The duct opens in the mesal branch of the embolus in both species. The lateral branch is much longer in *obtusus*.

Scylaceus pallidus Emerton

(Figures 77–80)

Tmeticus pallidus Emerton, Conn. Acad. Sci. Trans. 6: 55, pl. 16, fig. 4, 1882.

Erigone pallescens Marx, U. S. Nat. Mus. Proc. 12: 535, 538, 593, 1890.

Gongylidiellum pallidum Crosby, Phila. Acad. Nat. Sci. Proc. 1905, p. 339.

MALE. Length, 1 mm. Cephalothorax dusky orange-yellow sometimes narrowly margined with black; viewed from above evenly rounded on the sides, convergent towards the front, truncate in front, the eyes not occupying the whole width of head; viewed from the side steeply ascending behind to the dorsal groove and then gently rounded over the head to the posterior eyes. Clypeus straight and vertical.

Sternum dusky orange, darker at the margin, as wide as long, convex, sides rounded, produced into a truncate point between the hind coxæ which are separated by the diameter. Labium and endites dusky orange. No tooth on face of chelicera. Legs and palpus dull yellowish. Abdomen gray with scattered light spots and transverse lines.

Posterior eyes in a slightly procurved line, equal, the median separated by the diameter and slightly closer to the lateral. Anterior eyes in a straight line, median eyes smaller than the lateral,

oval, oblique, all separated by about the diameter of the median. A bunch of long hairs in median ocular area on a black spot. A single long hair on each side between the anterior median and posterior lateral eyes. Clypeus a little narrower than the median ocular area.

Femur of palpus long, slender, gently curved. Patella long, stout, widened distally, slightly arched above, armed with a row of 4 or 5 stiff hairs. Ratio of length of femur to that of patella as 18 to 10. Tibia strongly convex dorsally and dorsally produced into a very long, apically slender, long-pointed process which bears on the lateral side two triangular teeth, the basal one the larger. Paracymbium rather slender, very strongly curved and hooked. The bezel is moderately high with an evenly convex margin. Tail-piece of the embolic division short, rounded at tip with a rounded tooth on the side toward the middle of the palpus. The embolus arises directly from the tail-piece and is rather long, slender process curved in an open spiral. Median apophysis appears as a small, bluntly rounded tooth.

FEMALE. Length, 1.2 mm. Similar to male in form and color. The epigynum has the middle lobe narrowed in front and broadly widened and triangular behind.

Type locality: New Haven, Conn.

Illinois: Augerville, Oct. 4, 1928, 1 ♂; Nov. 27, 1928, 1 ♂ (Rutherford); Brownfield, Aug. 25, 1925, 2 ♀ (Smith); Salts, May 24, 1926, 1 ♂ (Smith); Urbana, June 29, 1925, 1 ♀ (Smith); Feb. 22, 1926, 6 ♂ 7 ♀ (Smith); May 3, 1926, 1 ♀ (Smith); May 14, 1926, 2 ♂ 1 ♀ (Smith); June 21, 1926, 1 ♀ (Smith).

Iowa: Traer, Nov. 5, 1931, 3 ♂ 1 ♀ (H. M. Harris); McGregor, winter, 1934, 1 ♂ 2 ♀ (Andre).

Kansas: Blue Mound, Douglas Co., 1924, 1 ♂ 1 ♀ (Baemer).

Maryland: Rockville, Apr. 29, 1924, 1 ♂.

Minnesota: Lake Minnetonka, July 31, 1924, 1 ♀ (Fletcher); Aug. 8, 1924, 1 ♀ (Fletcher); Aug. 28, 1924, 3 ♀ (Fletcher); June 22, 1926, 1 ♀ (Fletcher); June 30, 1926, 1 ♀ (Fletcher).

Missouri: Columbia, Feb., 5 ♂ 9 ♀; Mar. 1906, 82 ♂ and ♀; Apr., 1 ♀; May, 1 ♂; Oct., 2 ♂ 2 ♀; Nov., 5 ♂ 3 ♀.

New York: Albany, Apr. 9, 1931, 8 ♂ 4 ♀; Accord, Mar. 15, 1919, 3 ♂ 1 ♀; Belden Hill, Broome Co., May 19, 1923, 1 ♂ 1 ♀;

Enfield Glen, Apr. 22, 1925, 1 ♂ 2 ♀; Apr. 5, 1930, 4 ♂; English Church, Rockland Co., 1 ♂; Freeville, Oct. 12, 1924, 1 ♂ 1 ♀; Hither Hills, Apr. 5, 1931, 1 ♂; Ithaca, Feb., 1 ♀; Mar., 3 ♀; Apr., 3 ♂; Dec., 1 ♀; Jamaica, Apr. 7, 1923, 1 ♂ 5 ♀ (A. Wolf); Juanita Island, Lake George, Aug. 5, 1920, 1 ♀; Lake Keuka, Dec. 1903, 1 ♀; Dec. 1905, 1 ♂ 1 ♀; Larchmont, Sept. 26, 1925, 4 ♂ 1 ♀ (A. Wolf); Montour Falls, Oct. 12, 1924, 1 ♀; Mountain Lake, Fulton Co., Apr. 26, 1923, 2 ♂ 1 ♀; Pomona, Rockland Co., Apr. 12, 1923, 3 ♀; Sylvan Beach, July 1904, 1 ♀; Wells, Apr. 27, 1923, 1 ♂ 1 ♀; Wolcott, May 23, 1923, 2 ♂ 1 ♀.

North Carolina: Cowee Mts., Swain Co., Oct. 15, 1926, 1 ♂; Raleigh, Oct. 26, 1923, 1 ♂; Asheville, Sept.–Oct. 1934, 1 ♂ (Jacot).

Vermont: Pittsford, May 8, 1929, 2 ♂ 2 ♀.

Virginia: Alberta, Oct. 27, 1923, 2 ♂ 2 ♀; Great Falls, Apr. 3, 1921, 1 ♂.

Scylaceus obtusus Emerton

(Figures 81–83)

Tmeticus obtusus Emerton. Conn. Acad. Sci. Trans. 20: 149, pl. 2, fig. 4, 1915.

Male. Length, 1.5 mm. Cephalothorax greenish with indistinct darker radiating lines; viewed from above rather broad, rounded on the sides, strongly converging toward the front, nearly straight across the eyes. The head projects forward so that the anterior eyes are in profile. Cephalothorax viewed from the side gently ascending on the posterior declivity, then gently rounded over to the eyes, highest just behind the eyes. Clypeus straight and slightly protruding. Sternum and labium dark gray. Endites pale yellowish, grayish distally. Cheliceræ pale grayish yellow. Legs and palpi pale, dull grayish yellow, coxæ more grayish beneath, narrowly margined with black distally. Abdomen dark gray, nearly black. The epigastric plates abnormally developed, swollen, contiguous, the surface roughly pebbled. The spine on the posterior angle of the hind coxæ much larger than usual.

Posterior eyes in a very slightly procurved line, equal, the median separated by the diameter and from the lateral by the

radius. The anterior eyes in a slightly recurved line, the median separated by a little more than the radius and from the lateral by the diameter. Clypeus a little narrower than the median ocular area.

Femur of palpus rather stout, slightly widened toward the tip, strongly curved inward. Patella narrower than femur, slightly arched above, not concave below. Ratio of length of femur to that of patella as 17 to 7. Tibia produced dorsally into a broad, thin, truncate lobe with rounded corners; dorsolaterally there is a broad, rounded lobe separated from the dorsal lobe by a shallow rounded notch; the tip of the dorsal process thicker and darker in color, proximally from which it is thinner and lighter, a row of long stiff hairs just back of the margin of the lateral lobe. Paracymbium slender, strongly curved. Tail-piece of the embolic division a thin, elongate, pyriform lobe which lies across the tip of the bulb. From the base of the tail-piece there arises two black processes at right angles to each other, the one in line with the tail-piece ends in two sharp points twisted around each other, the other is shorter, truncate at tip, and has a minute notch at the tip, the opening of the ejaculatory duct. The median apophysis appears as a beak-shaped tooth under the edge of the cymbium, not shown in view given of the palpus.

FEMALE. Length, 1.4 mm. Similar to the male in form and color. The epigynum consists of a strongly convex plate, evenly rounded behind, with a large triangular notch in the middle occupied by the smooth white middle lobe.

Type localities: Jasper and Lake Louise, Alberta.

Colorado: Pingree Park, Larimer Co., Aug. 20, 1924, 5 ♂ 11 ♀, in moss by pond.

This species has also been recorded by Emerton from Canada: Jasper Park, Alberta.

SMODIX new genus

Type: *Tmeticus reticulatus* Emerton.

In this genus the stridulating plate on the under side of the abdomen is extraordinarily developed. The tibia of the male palpus is without a distinct process. The embolic division has a small triangular tail-piece. The embolus is fairly long, flat, and curved.

Smodix reticulata Emerton
(Figures 84–86)

Tmeticus reticulatus Emerton, Conn. Acad. Sci. Trans. 20: 148, pl. 2, fig. 3. 1915.

MALE. Length, 2 mm. Cephalothorax dusky over orange, darker at the margin and along the radiating lines; viewed from above, evenly and broadly rounded on the sides with scarcely any constriction at the cervical groove, broadly truncate across the front; viewed from the side, rounded over the posterior declivity and then gradually ascending to a slight hump back of the cervical groove where there is a broad shallow depression, then gradually ascending to a point in front of the posterior median eyes. Clypeus slightly convex and vertical. Median ocular area rugose, armed with a bunch of long, curved stiff hairs directed backward; back of the eyes a group of 5 or 6 stiff hairs directed forward and crossing the others. Sternum broad, dark brown, strongly convex. Endites dusky orange-yellow. Legs orange-yellow, coxæ suffused with dusky. Abdomen dark gray. On the ventral side of the abdomen in front of the epigastric furrow is a swollen, strongly chitinized plate; the middle part is hexagonally reticulate and the sides transversely striate. This is an extreme development of the stridulating organ.

Posterior eyes in a straight line, equal, the median separated by twice the diameter and from the lateral by about the diameter. Anterior eyes in a slightly recurved line, the median much smaller than the lateral, separated by the radius and from the lateral by nearly twice the diameter.

Femur of palpus moderately long, rather stout and curved inward, armed on the ventrolateral side with a row of 6 stiff hairs. Patella short, straight, slightly widened distally. Ratio of length of femur to that of patella as 22 to 9. Tibia ventrally as long as patella, broadly produced dorsally with the margin truncate, gently sinuate, the lateral angle armed with a black triangular incurved tooth; the margin next to the paracymbium broadly and evenly excavated. Paracymbium rather stout and strongly curved, base armed with a row of five slender, stiff hairs. The tegulum somewhat protuberant ventrally. The tail-piece of the embolic division ends in a flat triangular piece which lies over the

end of the tegulum. This is connected with the base of the embolus proper by a broad, thin section which is folded back toward the center of the bulb. The embolus itself is a stout, black style gradually narrowed toward the tip, the basal part is nearly straight; it then makes a sharp bend and terminates in two points.

FEMALE. Length, 1.7 mm. Similar to the male. The epigynum is a convex plate deeply notched behind. The openings are at the anterior end of the median fovea. The fovea is occupied by three plates, an anterior median one, pointed behind and two triangular lateral ones, the tips of which meet on the middle line.

Type localities: Lake Louise, Alta., and Laggan, B. C.

Alberta: Lake Louise, Aug. 12, 1927, 6 ♂ 1 ♀.

PLATE II

1. *Scotinotylus antennatus*, ♂, right palpus, lateral view.
2. *Scotinotylus antennatus*, ♂, right palpus, mesal view.
3. *Scotinotylus antennatus*, ♂, cephalothorax, dorsal view.
4. *Sisicottus montanus*, type of *nesides*, ♂, right palpus, tibia, full dorsal view.
5. *Sisicottus montanus*, *pidacitis* form, ♂, right tibia, dorsolateral view.
6. *Sisicottus montanus*, eastern form, ♂, right tibia, dorsolateral view.
7. *Sisicottus montanus*, type, ♂, right palpus, mesoventral view.
8. *Sisicottus montanus*, ♀, epigynum.
9. *Sisicottus montigenus*, ♂, right tibia, dorsolateral view, Mt. MacIntyre specimen.
10. *Sisicottus montigenus*, ♂, right tibia, dorsolateral view, Mt. Mitchell specimen.
11. *Sisicottis montigenus*, ♀, epigynum.
12. *Sisicus penifusiferus*, ♂, right palpus, mesal view.
13. *Sisicus penifusiferus*, ♂, right tibia, dorsolateral view.

13a. *Sisicus penifusiferus*, ♀, epigynum.

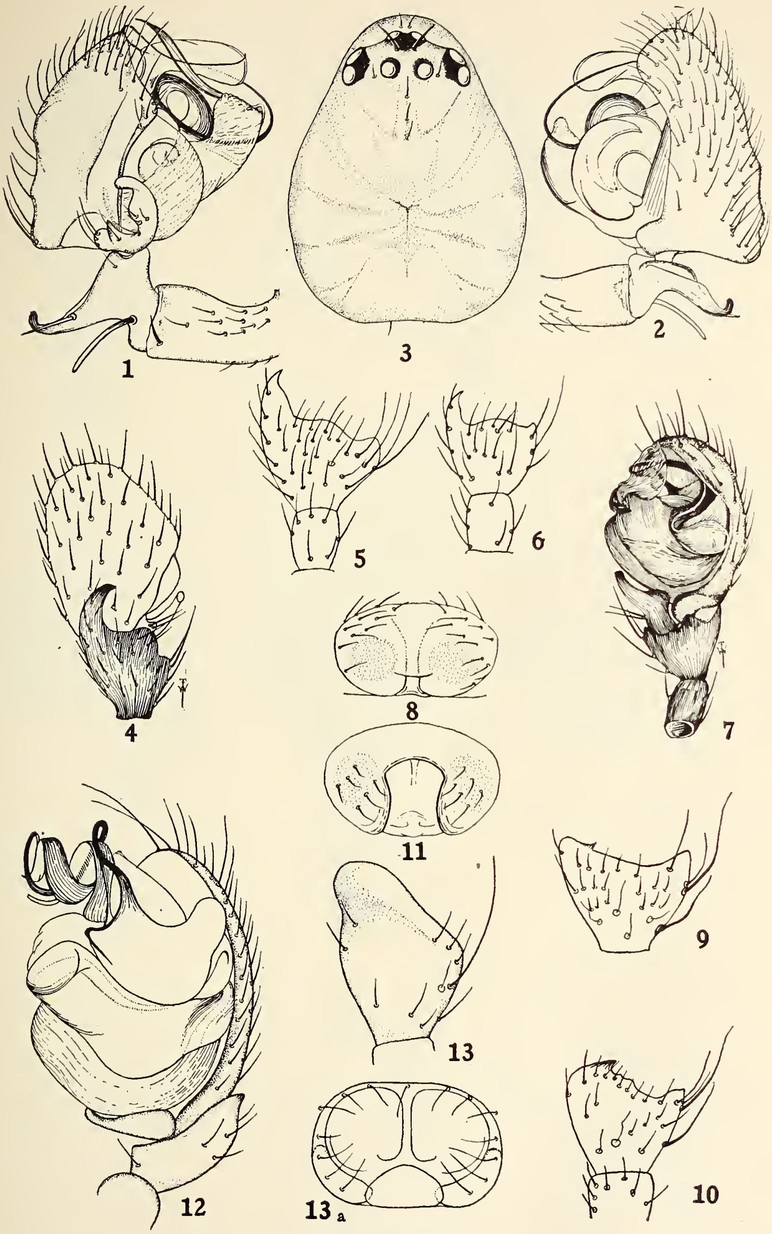


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PLATE III

14. *Scolopembolus littoralis,* ♂, right palpus, mesoventral view.
15. *Scolopembolus littoralis,* ♂, right tibia, dorsal view.
16. *Scolopembolus melacrus,* ♂, left palpus, mesoventral view (from type).
17. *Scolopembolus melacrus,* ♂, left tibia, dorsal view.
18. *Trœmatosisis bispinosus,* ♂, right palpus, mesal view (from type).
19. *Trœmatosisis bispinosus,* ♂, right palpus, ventral view.
20. *Trœmatosisis bispinosus,* ♂, right tibia, dorsal view.
21. *Trœmatosisis bispinosus,* ♂, left tibia, dorsal view.
22. *Sisis rotundus,* ♂, right palpus, mesoventral view.
23. *Sisis rotundus,* ♂, right tibia, dorsal view.
24. *Sisis rotundus,* ♀, epigynum.

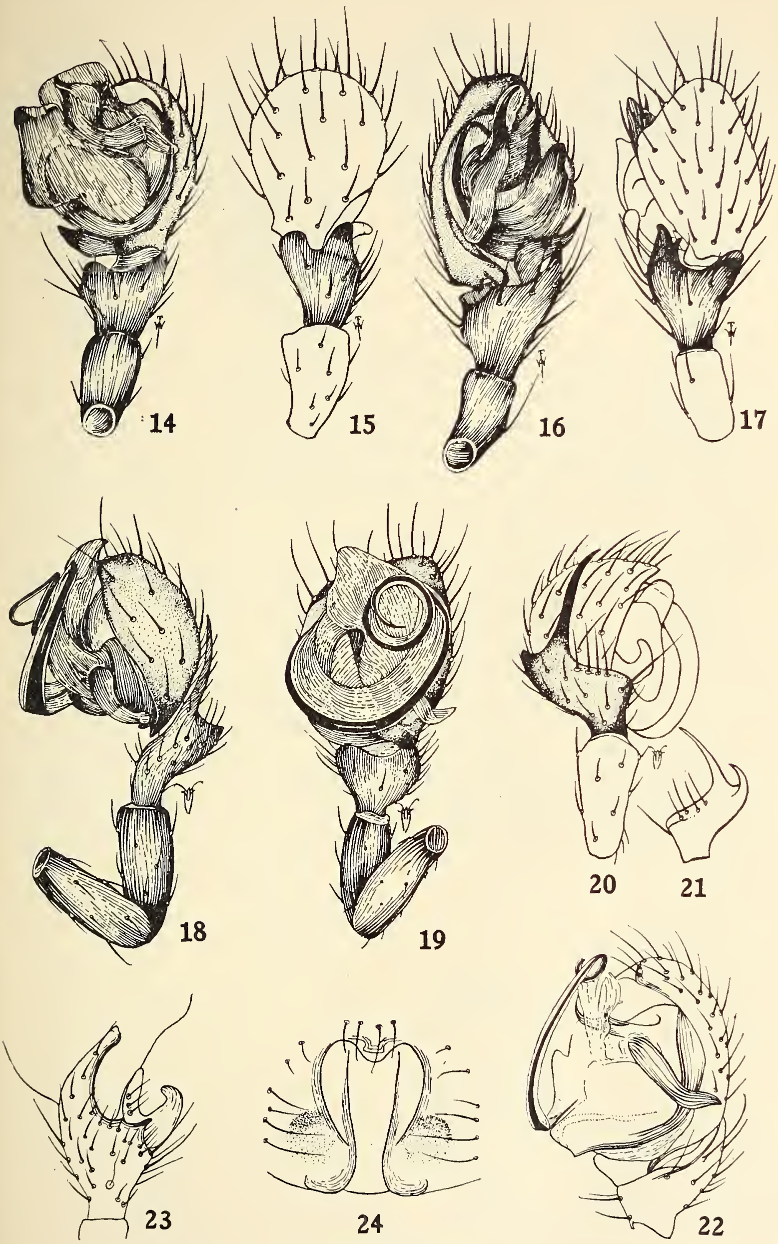

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PLATE IV

25. *Dicymbium elongatum,* ♂, right palpus, dorsal view.
26. *Dicymbium elongatum,* ♂, right palpus, ventral view.
27. *Dicymbium elongatum,* ♂, right palpus, mesal view.
28. *Dicymbium elongatum,* ♂, right palpus, lateral view.
29. *Dicymbium elongatum,* ♂, cephalothorax, dorsal view.
30. *Dicymbium elongatum,* ♀, epigynum.
31. *Scirites pectinatus,* ♂, right palpus, mesoventral view.
32. *Scirites pectinatus,* ♂, right tibia, dorsolateral view.
33. *Scirites pectinatus,* ♂, tarsus and metatarsus of first leg.
34. *Scirites pectinatus,* ♀, epigynum.
35. *Scironis tarsalis,* ♂, right palpus, ventral view.
36. *Scironis tarsalis,* ♂, right tibia, dorsal view.
37. *Scironis tarsalis,* ♂, right tibia, dorsolateral view.
38. *Sinoria rapidula,* ♂, right palpus, mesoventral view.
39. *Sinoria rapidula,* ♂ right tibia, dorsal view.
40. *Sitalcas ruralis,* ♂, right palpus, lateral view.
41. *Sitalcas ruralis,* ♂, right tibia, dorsal view.
42. *Sitalcas ruralis,* ♀, epigynum.

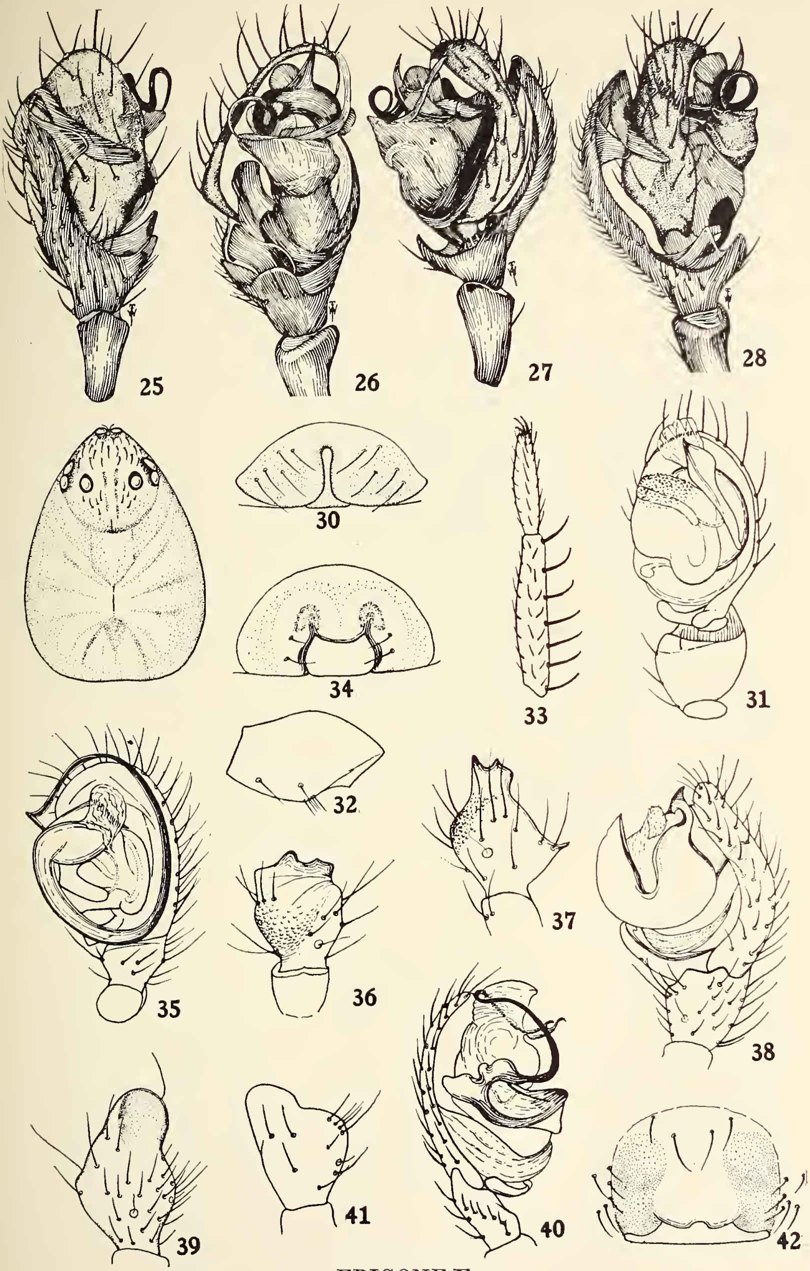

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PLATE V

43. *Sciastes acuminatus,* ♂, right embolus.
44. *Sciastes acuminatus,* ♂, right tibia, dorsolateral view.
45. *Sciastes acuminatus,* ♂ right tibia, dorsal view.
46. *Sciastes concavus,* ♂, right palpus, dorsal view.
47. *Sciastes concavus,* ♂, right palpus, mesal view.
48. *Sciastes microtarsus,* ♂, right palpus, mesal view.
49. *Sciastes microtarsus,* ♀, epigynum.
49a. *Sciastes microtarsus,* ♂, right tibia, dorsal view.
50. *Sciastes simplex,* ♂, right palpus, mesoventral view.
51. *Sciastes simplex,* ♂, right tibia, dorsal view.
52. *Sciastes simplex,* ♂, right palpus, dorsolateral view.
53. *Sciastes simplex,* ♀, epigynum.
54. *Sciastes terrestris,* ♂, right palpus, mesal view.
55. *Sciastes terrestris,* ♂, right tibia, dorsal view.
56. *Sciastes terrestris,* ♀, epigynum.
57. *Sciastes truncatus,* ♂, right palpus, mesoventral view.
58. *Sciastes truncatus,* ♂, right tibia, dorsal view.
59. *Sciastes truncatus,* ♀, epigynum.

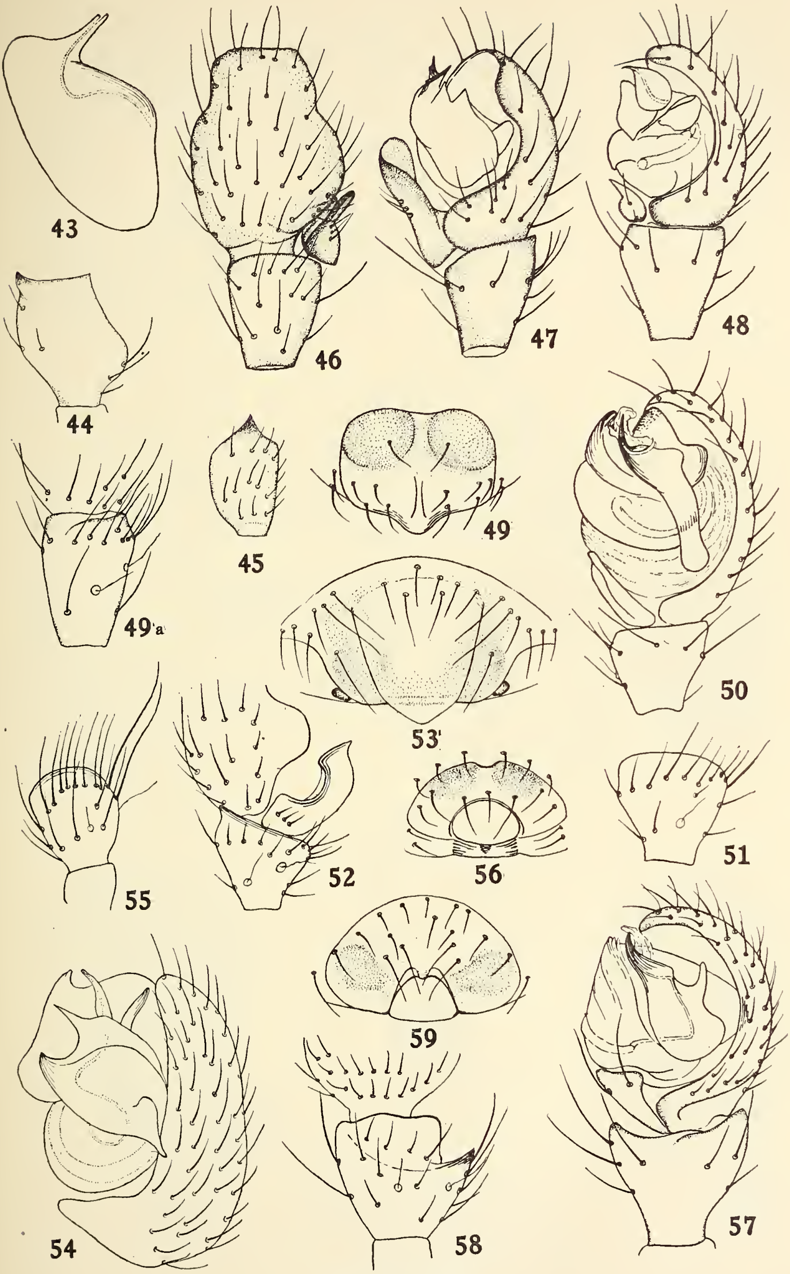

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PLATE VI

60. *Sciastes ursinus*, ♂, right palpus, mesoventral view.
61. *Sciastes ursinus*, ♂, right tibia, dorsal view.
62. *Sciastes vicosanus*, ♂, right palpus, mesoventral view.
63. *Sciastes vicosanus*, ♂, right tibia, dorsal view.
64. *Sciastes vicosanus*, ♀, epigynum.
65. *Gnathonaroides pedalis*, ♂, right palpus, lateral view.
66. *Gnathonaroides pedalis*, ♂, right palpus, mesal view.
67. *Sisyrbe rustica*, ♂, left palpus, ventral view.
68. *Sisyrbe rustica*, ♂, left palpus, dorsal view.
69. *Scotoussa bidentata*, ♂, right palpus, mesoventral view.
70. *Scotoussa bidentata*, ♂, tibia, dorsal view.
71. *Scotoussa bidentata*, ♀, epigynum.


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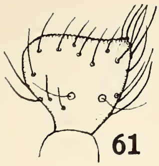
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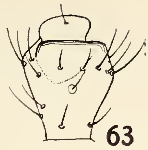
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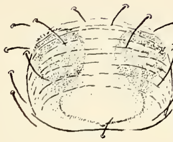
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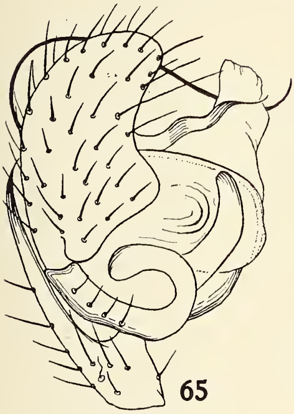
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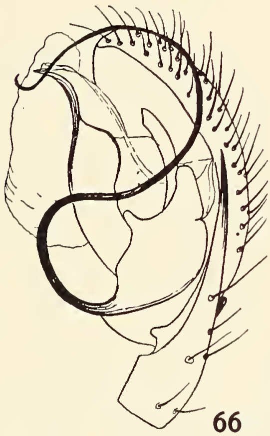
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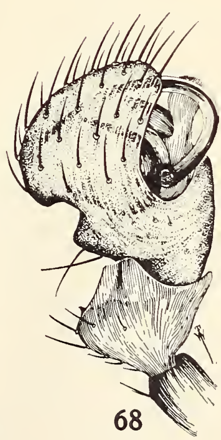
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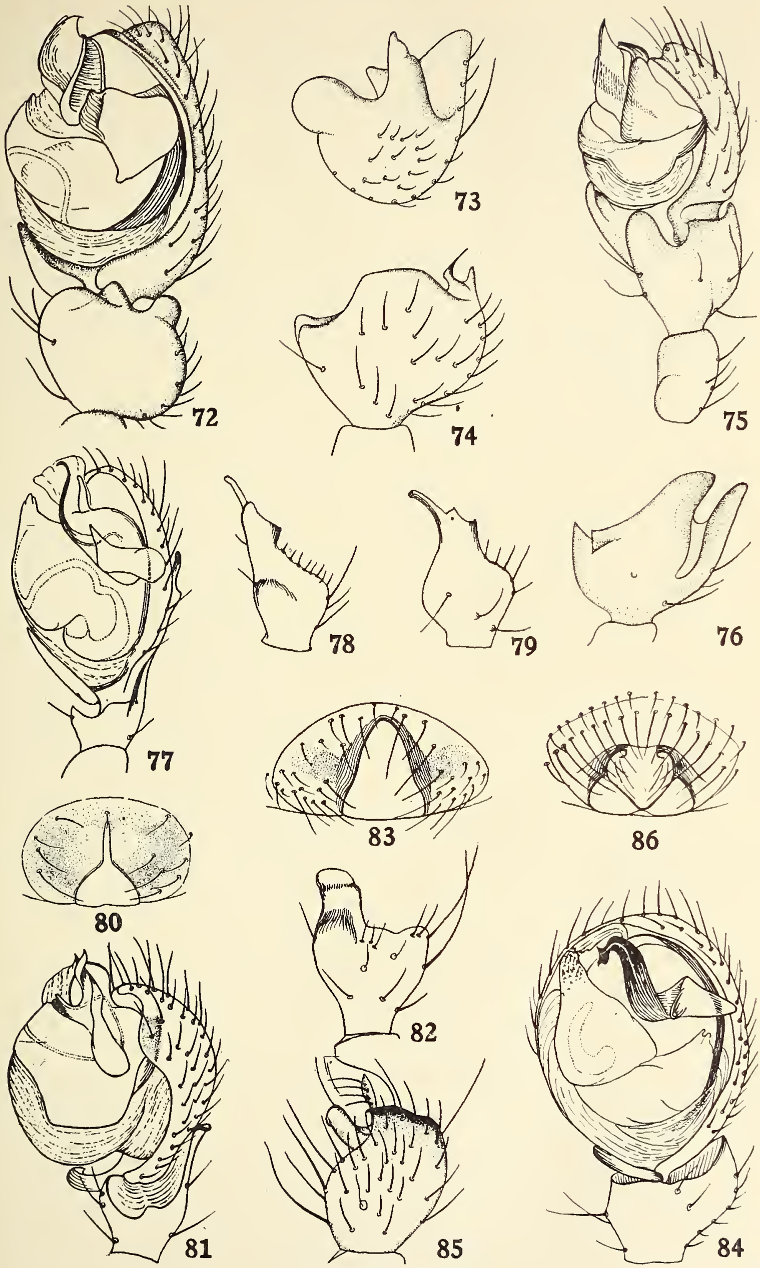
PLATE VII

72. *Scyletria inflata*, ♂, right palpus, mesal view.
73. *Scyletria inflata*, ♂, right tibia, dorsolateral view.
74. *Scyletria inflata*, ♂, right tibia, mesal view.
75. *Scyletria jona*, ♂, right palpus, mesal view.
76. *Scyletria jona*, ♂, right tibia, dorsomesal view.
77. *Scylaceus pallidus*, ♂, right palpus, mesoventral view.
78. *Scylaceus pallidus*, ♂, right tibia, dorsal view.
79. *Scylaceus pallidus*, ♂, right tibia, mesodorsal view.
80. *Scylaceus pallidus*, ♀, epigynum.
81. *Scylaceus obtusus*, ♂, right palpus, mesal view.
82. *Scylaceus obtusus*, ♂, right tibia, dorsal view.
83. *Scylaceus obtusus*, ♀, epigynum.
84. *Smodix reticulata*, ♂, right palpus, ventral view.
85. *Smodix reticulata*, ♂, left tibia, dorsal view.
86. *Smodix reticulata*, ♀, epigynum.



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Certificate of Incorporation expires June 7, 1943

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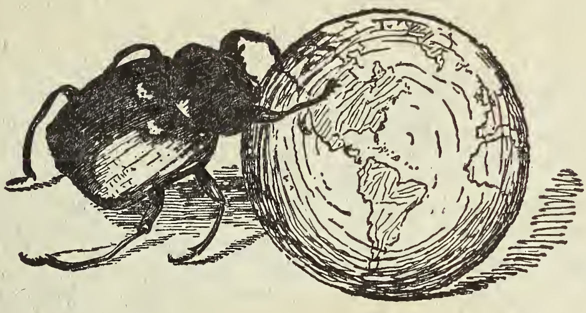

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JOURNAL

OF THE

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Vol. XLVI June, 1938 No. 2

MORE BOX-MITES OF THE NORTHEASTERN UNITED STATES

By Arthur Paul Jacot
Northeastern Forest Experiment Station,
New Haven, Connecticut

This is an unexpected addition to my earlier paper (15). At that time I thought I had secured all species of Phthiracaridæ of Connecticut. By collecting in new habitats (bogs, old pine woods) and new localities (the much more rugged northwest corner) I have to add several species to the New England list. Illustrations of species not yet figured will appear in the "Manual of East American Phthiracaridæ."

Since the publication of the earlier paper, Grandjean has introduced a new set of terms for some of the parts. (11). I am retaining mine (15, p. 221) as having precedence. The synonyms are:

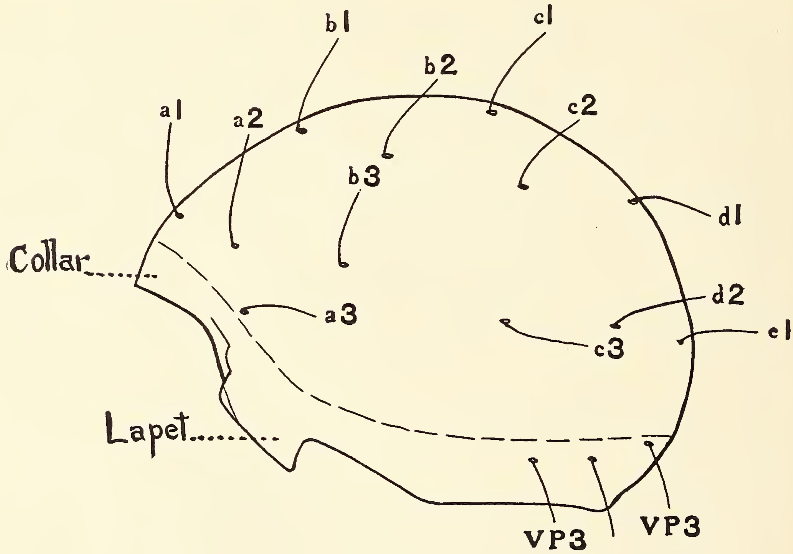
Jacot	Grandjean
anal rods	anal plates
anal covers	anal-adanal plates
genital shields	genital plates
genital covers	genital-aggenital plates
anogenital plates, in Oribotritia	adanal and aggenital plates
anogenital plates, in Pseudotritia	genital, aggenital, anal, adanal
infolded part of ventral plate	plicature plates

Following Oudemans, I regarded the complex of anogenital plates of Oribotritia as due to splitting of the plates as found in

Phthiracarus to give greater flexibility in a much contracted and much folded area. Grandjean considers the condition in Oribotritia as the more primitive and the one in Phthiracarus as due to fusion. As there is more evidence for accepting Grandjean's viewpoint than Oudemans' I will henceforth reverse the order of genera placing Oribotritia first and the Phthiracarini last.

I am still unable to find a suture between the outer part of the ventral plate and the part which is folded inward and which Grandjean calls, "plicature plate". As far as I can determine this is a sharply folded, V- shaped ventral plate.

Until the homology of the bristles has been worked out with some degree of certainty, I am retaining my notation of the notogastral bristles with the modifications stated in a more recent paper (16), which places the emphasis on the transverse arrange-



ment (text figure). This is in harmony with transverse segmentation, while the longitudinal arrangement inaugurated by Berlese in other genera has no phylogenic basis. The notation of the bristles of the anal area in the Phthiracarini, as used by Grandjean is as follows:

Jacot	Grandjean
—	a1 (a = anal)
I:1	a2
I:2	a3
II:1	ad1 (ad = adanal)
II:2	ad2
II:3	ad3

I am retaining my enumeration as having precedence but will use Grandjean's a1 for the bristle of the interlocking triangle. As this notation may be confused with bristles a1 of the notogaster, I prefer to use it in unabbreviated form (anal 1). I had formerly used I:3 for the posterior bristle, but later (16, pp. 247–248, txt. fig. 2) pointed out that I:3 really belonged to the lateral row. This necessitated changing the enumeration from I:3 to II:3.

I find no reason for studying the mouth parts and legs of the Phthiracarinæ at the *present* time. I do not consider that the specific differences in the *mandibles* are of such systematic value as to warrant spending the necessary time to figure or note them. Their study may have academic value. That is for another generation to determine.

In November 1930 (15) I found that Acarus was a Greek neuter noun and have used it as such. Grandjean has called to my attention that Linné, its original user in systematic literature, used it as a masculine noun as have subsequent writers. As the International Rules of Zoölogical Nomenclature do not cover such usage, I will hereafter follow the usage of Linné.

Types are to be deposited at the Museum of Comparative Zoölogy.

Subfamily PROTOPLOPHORINAE (15, p. 210)

Phthiracaridæ with more or less distinct transverse segmentation at least in the immature stages, and a long beaklike aspis (10).

Type: Protoplophora (4, p. 217).

Tribe PROTOPLOPHORINI trib. nov.

Phthiracarinæ with dorsal area of abdomen covered by at least two notogastral plates, the posterior one (pygidium) capable of telescoping under the anterior one (pronotaspis) and usually found in this position in preserved

material; sides covered by freely movable, lateral plates (pleuraspides), as far as now known, one on each side.

Type: Protoplophora (4, p. 217).

Chiefly tropical and subtropical.

Tribe PHTIRACARULINI **trib. nov.**

Protoplophorinæ with pygidium and pleuraspides fused to form an unusually deep and saclike ventral plate.

Type: Phtiracarulus (5, p. 149).

Genus PHTIRACARULUS (5, p. 149)

This is the only genus of Phthiracarulini at present known.

Type: *Phtiracarus* (*Phtiracarulus*) *perexiguus* (5, p. 149).

I regard this as the most highly developed Protoplophorinæ known to date.

Phtiracarulus laevis *sp. nov.*

(Figures 1 to 5)

Diagnositc characters: Pseudostigmatic organ head very slender, long-pointed, smooth; aspis and notogaster with very fine, fairly short bristles.

Description: Size small, length (more or less contracted) 0.28 mm.; greatest length of notogaster 0.23 mm., tip of aspis to anterior edge of pseudostigmata 0.13 mm., thus much smaller than the genotype from Italy; color amber yellow (no red); aspis smooth, produced anteriorly in middle and thus much produced downward, hooklike in lateral aspect, as in the Protoplophorinæ), rim slender, widening slightly posteriad, ventroproximal edge convex, posteroventral corner thickened; pseudostigmata not projecting, exterior portion a simple opening, the organ quite long, slender, sinuous, held lateral (figures 1 and 2), in some individuals a series of very fine cilia may be discerned near distal end; exopseudostigmal bristles very fine, short, to indiscernible.

Notogaster with a fairly deep flange (cloison of Grandjean (13) along anterior edge, and a very deep one along posterior edge (figure 1); with all this unusual development of the flange, the lip (limbe of Grandjean (13) is quite short; anterior edge drawn out in center into a well-developed lobe; with twelve bristles (at least I am unable to discern more): eight dorsal and dorsolateral, and four along upper edge of flange, these four posterior bristles are longer and stouter than the others.

Ventral plate very broadly continuous behind anal aperture (figure 1, not 2). This plate includes the pygidium (metanotaspis) of the Protoplophorinæ. This is evident from two factors, namely, the presence of the six bristles around its posterior end, and the presence of a ridge or suture which, in the tritonymphs, extends between the lowest two of these six bristles and the others (figure 4). This suture represents the border between the ventral plate and the pygidium. The posterior end of this suture is evanescent, incomplete.

In the deutonymphs it is complete around the posterior end and the pygidium is more developed. Thus in this genus one has an actual transition in the fusion of two plates. Actually the ventral plate is made up of the fused pair of pleuraspides of Grandjean (10) which bear two bristles each. The other four bristles are characteristic of the lower edge of the pygidium. Moreover, in the nymphs the notogaster is obliquely truncate, as in the Protoplophorinæ. In the adult this truncation is lost by an extension of the lower edge of the notogaster leaving the two peripheral bristles remote from the ventral edge (compare figures 1 and 4).

Anal covers slender, each with three very fine bristles; anal covers set in a single plate which, in ventral aspect (figure 2), presents an edge view except at anterior end where it appears triangular (each side). Each triangle with two insertions (figure 2). I find no suture or break on the median plane. Genital covers (figure 3) quadrilateral, with a spur at anterolateral corner which fits under ventral plate, anterior edge thickened (figure 2), at least five bristles along mesal edge, two at posterior end of lateral edge, and two near center. It is difficult to account for this three ranked arrangement. In the tritonymphs the median edge of the genital covers is produced anteriad as a spur nearly as long as the body of the covers.

Palp segments similar to leg segments. Legs not unusual; ungues monohamate.

Egg large, reniform, situated at bottom of ventral plate.

Quite similar to *Phthiracarulus rostralis* (23, p. 245, Figs. 8–9) from Guatemala but differs in the following respects: rostral bristles evident; notogastral bristles fewer, the posteroventral much longer, VP1 not discernible; lateral bristles of genital covers two; posterior bristles of ventral plate reduced to four (each side).

Material examined: Ten specimens from sphagnum moss, bog, Bethany, Conn.; taken June 22, 1932, slide 3220h1. Three hundred ninety-seven specimens from mat of the sedge *Carex trisperma billingsii* of same bog; same date, slides 3221h1, -h2, -h3, and -nh (all *cotypes*). Eight specimens from leaf mould, sphagnum, and mosses from foot of eight inch Tamarack and from under blueberry bushes, Tamarack swamp at foot of Rabbit Hill, town of Warren, Conn.; taken August 26, 1932, slides 3250h7, -h8, -h11, and -h12. Five specimens from deciduous litter (including Rhododendron) from top of Riga Mountain near Bingham Pond (west side of road); taken August 6, 1932, slides 3232h3 and -h4. Ninety-nine specimens from other side of road, on burn of May 4, 1930, slide 3231h1 and -h4. Nine specimens from

decayed spruce stump and blueberry leaf mould and moss, side of Bingham Pond; same date, slide 3233h1. Four specimens from well decayed, fallen hemlock bole, half-way up Sage's Ravine (south side) northeast corner of Connecticut; taken August 17, 1932, slide 3239h2. Twenty-nine specimens from laurel litter, same spot and date, slides 3240h1 to -h3. One specimen from dry hemlock mould with moss, cliffy rocks, same locality and date, slide 3241h3.

Habitat: This species would thus seem to prefer rather wild situations little polluted by man.

Subfamily PHTHIRACARINÆ (15)

Phthiracaridæ with notogaster of adults formed of one plate, immature stages soft, white; aspis never produced ventrad on median line to form a hooklike beak.

Type: Phthiracarus (21, p. 874).

Tribe EUPHTHIRACARINI (15, p. 241)

Phthiracarinæ with ventral plate strongly folded longitudinally each side (bellows-like) very narrow posterior to anus; anal and genital plates or covers very narrow.

Type: Euphthiracarus (9, p. 132).

KEY TO GENERA

1. Anogenital area covered laterally by two long plates (anogenital), mesally by two pairs of slender plates: a genital pair (genital shields) and a very slender anal pair (anal rods) 2
1. Anogenital area covered by only two long plates (anogential) 3
2. Genital shields as broad at anterior as at posterior end; each anogenital plate with four bristles along posterior half; aspal bristles erect; notogastral bristles thirty .... *Protoribotritia*
2. Anterior end of genital shields much constricted and produced anterodorsad; each anogenital plate with but three bristles along posterior half; aspal bristles prone; notogastral bristles twenty-eight or less .... *Oribotritia*
3. Aspis small, anterior end depressed; aspal rib short; surface of notogaster stippled to finely scrolled .... *Pseudotritia*
3. Aspis large, anterior end high, full, rib extending to center of aspis; surface of notogaster sculptured .... *Euphthiracarus*

Genus PROTORIBOTRITIA gen. nov.

Resembling Oribotritia but with thirty notogastral bristles, four bristles on posterior half of each anogenital plate (paranal), three on each anal rod; aspal bristles erect.

Type: *Protoribotritia canadaris* sp. nov.

Protoribotritia canadaris *sp. nov.*
(Figures 6 to 8)

Size small, diagonal length of notogaster 0.365 mm., breadth and height 0.24 mm., length of aspis 0.2 mm., anterior edge of pseudostigmata to distal end of aspis 0.127 mm.; color pale straw, ''stomach'' contents pink, amorphous, giving the species a characteristic appearance quite different from any other species known to me; aspis high, without rim, carina, or ridge; pseudostigmata not projecting, merely a small opening internally enlarged and chambered (figures 6 and 8); pseudostigmatic organs well developed, held at right angle to aspis, clavate, head held somewhat erect, distal end constricted much as a lead pencil, with two or three short bristles each side (figure 6); a prominent, internal rib running from pseudostigmata to lower edge of aspis (figure 8); rostral bristles inserted some distance from distal end of aspis, remote! (figure 7), medium long; lateral bristles longer, more approximate (figure 7); vertex bristles very long (figure 8), slightly more remote than rostral (figure 7); collar barely distinguishable; lapet streamlined; bristles a1 distant from anterior edge of notogaster, other bristles disposed as in figures 7 and 8, b1 variable in position; all bristles fine, flexuous; anogenital area as in Oribotritia but anterior end of genital shields not constricted, not produced as a horn anteriad and dorsad (interiorly), each with six bristles inserted some distance from mesal edge of shield; usual two anterior insertions of anogenital plates rather close together, those of posterior half subequally spaced, the bristles as long as notogastral; anterior insertion of anal rods near anterior edge, middle insertion on anterior third, posterior insertion on posterior third (figure 7).

Legs not unusual, tarsi I and II with a long, stout, slightly decurved bristle; ungues monohamate. Palps four segmented, penultimate segment half as long as distal or second, distal segment with distal half much more slender than proximal half, bearing a bristle similar to that of tarsi I and II.

Material examined: One specimen from leaf mould, sphagnum and other moss from foot of eight inch tamarack, and from under blueberry bushes, Tamarack swamp, head of valley at foot of Rabbit Hill, town of Warren, Conn.; taken August 26, 1932, slide 3250h11. One specimen from Rhododendron and oak litter, top of Riga Mountain, near Bingham Pond (east of road), northwestern Conn.; taken August 6, 1932, slide 3232h4. Five specimens from across road on burn of May 4, 1930, slides 3231h1 and -h4. Six specimens from pine leaf-mould and duff, foot of white pines, east slope of Pleasant Hill, Etna, Tompkins Co., N. Y.; taken October 15, 1932, slides 3289n3, 3290h1, 3290h2. Thirty-one specimens from pine leaf mould from base of pine, crest of Con-

necticut Hill, Newfield, Tompkins, Co., N. Y.; taken November 25, 1932, slides 32109h1 and -h2 (*cotypes*).

It is interesting to find this evidently Canadian life zone species in Connecticut but in very small numbers (lot 3250 yielded 713 other Phthiracarids, lot 3232 yielded a total of 101).

Oribotritia banksi (20)

Efforts were made to secure this species along the southern edge of Connecticut but without success. Its northern limit is still Long Island, N. Y.

Genus PSEUDOTRITIA (22, p. 552)

Euphthiracarini with anogenital area covered by only two long plates (anogenital) the median edge of which bears a triangular series of interlocking ridges; aspis small, anterior end depressed; aspal rib short; surface of aspis and notogaster stippled to finely scrolled.

Type: *Tritia* (*Pseudotritia*) *monodactyla* (22, p. 552, fig. 1).

Pseudotritia ardua, (18, fasc. 32/15)
(Figure 10)

This species has already been fully described (15, p. 243, pl. 38, figs. 44–51, pl. 35, fig. 25) and commented on (16, pp. 255 to 258). I now include a figure of the extruded ovipositor (figure 10). In my earlier paper (15) the legend under the specific name (p. 243) should read: figs. 44–51, pl. 35, fig. 25. Bristles anal 1 are present but so short as to be visible only when seen somewhat obliquely, that is they do not project beyond ventral edge of anogenital plate when specimen is viewed in true lateral aspect. These bristles are normally curved backward. In figure 44 (15) my III : 3 of page 245 (as pointed out by Grandjean (13) is the opening to the abdomino-lateral gland, the bristle below it is III : 3. The abdomen may be so compressed that the dorsal and posterior faces form a sharp angle (like a gable roof), or it may be so broad as to form a rounded dorsal and posterior face. These differences in degree of compression may be sexual.

In its various forms but chiefly as the typical form I have it from lots as follows and as presented in the Table of Occurrences at the end of this paper.

Material examined: Three specimens from epigeous moss clumps, in thicket, edge of swampy woods, East Village, Monroe, Conn.; taken January 18 (a week after a fifteen degree freeze) 1932, slide 322h. One specimen from leaf litter, woodland slope, East Village, Monroe, Conn.; taken March 31, 1932, slide 328nh. Four specimens (two with pock-marks on the *inner* face of the notogaster!) from hickory shag from base of bole of a hickory in vacant lot on Coscob headland, Conn.; taken April 12, 1932, slide 3212h. Three specimens from well decayed stump of white cedar, epigeous moss and litter from small white cedars, Bethany bog, Conn.; taken June 22, 1932, slide 3223h. Three specimens from oak leaf litter and duff, sandy ridge northeast of North Haven, Conn.; taken September 14th (dried the 23rd), slide 3267h. Three specimens from same spot but almost exclusively leaf mould, slide 3270h2. One specimen from decayed oak branches lying on ground, same spot as last; dried September 28, slide 3271h. Thirty specimens from ericaceous leaf mould among pines, sand barrens between North Haven and Northford (charred leaf mould common); dried September 29, slides 3272h and 3273h. Twelve specimens from scrub-oak litter from base of sprout clump, same locality; dried October 6, slides 3276h and 3277h. One specimen from lower, mucky layer of sphagnum, below the frozen layer, in swale, below road below wooded ridge of Connecticut Hill, Newfield, Tompkins Co., N. Y.; taken November 25, 1932, slide 32107h. Three specimens from trash, Columbia, Mo., taken by C. R. Crosby, in Cornell Univ. Coll., determined by Ewing as *Phthiracarus americanus* (as well as an accompanying *Euphthiracarus flavus*).

From the collection of August E. Miller, I have before me a flower-bed marker of white pine which had been treated with corn syrup solution by boiling for one hour. This stake was then exposed outdoors to termites and became infested with *Pseudotritia ardua* which had eaten into the stake. It was then sealed into a glass tube by Dr. Miller. When I examined the stake, it was riddled with the galleries of this mite, the bodies of the adults being on the surface of the wood and in the ends of the burrows. Moreover, the surface of the stake was heavily coated with the fæces and frass of the mites. Thus it is evident that this species

will readily eat out wood, especially if impregnated with food. It is possible that the mites were attracted by fungi which may have developed on the syrup rather than by the syrup itself. The stake had not been rendered punky by fungus digestion. At any rate this is experimental evidence that these mites are the termites of the northern woods.

Thus this species is again seen to be common under most conditions but not in extremely wet situations as sphagnum of an open bog (but see 32107, and another in the overlying frozen layer (not otherwise recorded, slide 32106o1). It is of particular note that it is almost the only Phthiracarid secured in the pine-oak sand barrens between North Haven and Northford (the exceptions being *Pseudotritia simplex* and *Phthiracarus setosus*).

Pseudotritia ardua curticephala *subsp. nov.*

Pseudostigmatic organ head short, truncate with about eight fairly long, stiff bristles directed distad (rather than laterally); rib which, in the species passes along ventral edge of pseudostigmata (15, pl. 38, fig. 44), is here broken below the pseudostigmata, so that the anterior half abuts against front edge of pseudostigmata while the posterior half passes ventrad beyond the pseudostigmata; vertex bristles nearly as short as lateral, truncate; sculpture of aspis and notogaster coarsely scrolled (vermiculate); center of aspis and anogenital plate somewhat pocked; anterior half of anogenital plate with a low longitudinal ridge near its center (visible only in ventral aspect), bristle of interlocking triangle longer, plainly visible in lateral aspect, an additional insertion on mesal edge of anogenital plate just beyond triangle; two bristles on rim of anogenital plate subequal to or slightly longer than the others; size not large, diagonal length of notogaster 0.4 mm., height of notogaster 0.25 mm., end of aspis to anterior edge of pseudostigmata 0.16 mm.

Material examined is entered on Record of Occurrences. The forty cotypes are on slide 3239h1. It is interesting to note that this evidently Canadian life zone form is in some cases found in the same lot with the species, being easily distinguished by the much smaller size. This and the difference in the trussing of the lower edge of the aspis lead me to wonder if it is not a full species. More distributional data is needed to settle this point.

Pseudotritia simplex (15, p. 248)

Aspis with a low ridge, much as in *Pseudotritia ardua;* rim slender, terminating at distal end of carina; rostral bristles short,

very fine, close together, inserted at distal end of ridge, lateral bristles more anterior than usual, only slightly more remote than rostral!; vertex bristles remote, not distant from pseudostigmata which are reduced externally to a simple opening; pseudostigmatic organ head with blunt distal end.

Notogaster with short, very fine bristles. Compared to *Pseudotritia ardua* these bristles have migrated forward so as to be unusually concentrated about dorso-lateral areas. Anogenital plates as in *Pseudotritia ardua* but bristles of both genital and anal areas reduced to four. Of these the last two of anal area are much longer and correspondingly stouter. These two long bristles are inserted anteriad and posteriad of transverse plane of VP2. It is therefore difficult to say what bristles they represent. In Euphthiracarus the peripheral bristles (I:1 and I:2) are much longer than the others while in *Pseudotritia ardua* they are shorter.

The eggs are fairly closely armed with prominent decurved spines, giving it a very burry appearance. I have not noticed more than three per female at one time.

Material examined in addition to the material recorded on Record of Occurrences: Thirty specimens from sphagnum moss, open bog, Bethany, Conn.; taken June 22, 1932, slide 3220h1. Forty-six specimens from mat of the sedge *Carex trisperma billingsii,* same bog, same date, slide 3221h1, -h2, -h3 and -h4. Thirty-five specimens from well decayed stump of white cedar, epigeous moss, and litter of small white cedars, same bog and date, slide 3223h. Twelve specimens from coarsely foliose and fruticose lichens and Selaginella covering large boulders and ledges, short way up south side of Sage's ravine, northwest Conn.; taken August 6, dried August 16, 1932, slide 3238h1. One specimen from oak leaf litter and duff, sand ridge northeast of North Haven, Conn.; taken September 14, dried the 23rd, slide 3267h. One hundred fifty specimens from same spot as preceding lot but almost exclusively duff, dried September 26, slides 3269h1 to -h5. Fourteen specimens from same spot as lot 3267 but almost exclusively leaf litter, dried September 27, slide 3270h1. Nine specimens from scrub oak litter from base of sprout clump, sand barrens between North Haven and Northford, Conn.; taken September 14, dried October 6, slides 3276h, 3277h.

From these records this species seems to be tolerant of a great variety of conditions.

Genus EUPHTHIRACARUS (9, p. 132)

Euphthiracarini with anogenital area covered by only two long plates (anogenital); aspis large, anterior end high, full, rib extending to center of aspis; pseudostigmata with shelf along lower edge; surface of notogaster, as well as of aspis and anogenital plates, sculptured.

Type: *Phthiracarus flavus* (7, p. 450, Fig. 1).

KEY TO SPECIES

1. Pseudostigmatic organs with broad head 2
1. Pseudostigmatic organs bristlelike, ciliate 4
2. Sides and top of aspis pocked; notogastral bristles short, stout, stiff. *E. crassisetæ*
2. Sides of aspis smooth; notogastral bristles fine, flexuous 3
3. Anterior end of aspis depressed, flattish, much as in Pseudotritia, carina double as in Euphthiracarus; rib fine, faint; rostral bristles porect, gently curved; the four bristles of posterior end of anogential plates subequally spaced, the posterior one (II: 3) at least as long as notogastral bristles I: 5; II: 1 much nearer I: 1 than to anal 1. .... *E. depressculus*
3. Anterior end of aspis high, angular; carina simple, as in Pseudotritia; rib well developed; rostral bristles with distal half bent; the four bristles of posterior end of anogenital plates with posterior one more distant and shorter than notogastral bristles I: 5; II: 1 distant from I: 1, midway between I: 1 and anal 1. .... *E. punctulatus*
4. Dorsal face of aspis pocked; pseudostigmatic organs bristlelike, bilaterally ciliate; notogaster high .... *E. flavus*
4. Pocking confined to distal end of aspis; pseudostigmatic organs with distal third slightly swollen, cilia two ranked but on the same side; notogaster of usual height .... *E. flavus pulchrus*

Euphthiracarus depressculus (14, p. 90, Figs. 1–6)

This species is related to Pseudotritia in the shape of the aspis and diminutive rib, but the double carina and sculpturing relate it to Euphthiracarus. The pseudostigmata moreover have shelf along ventral edge, and anogenital plate bristles a1 are long.

Material examined: One specimen from dry hemlock mould, moss and Selaginella of cliffy rocks, south side of Sage's Ravine, northwestern Conn.; taken August 23, 1932, slide 3241h1. Three specimens from inner layers of well decayed hemlock branch,

lying in pine-hemlock gully, east side of Pleasant Hill, Etna, N. Y.; taken November 3, 1932, slides 32100h and 32101h. One specimen from lower mucky layer of sphagnum (below the frozen layer) about tree stump, in swale below road below wooded ridge of Connecticut Hill, Newfield, Tompkins Co., N. Y.; taken November 25, 1932, slide 32107h. One specimen from epigeous moss, and lichens from old wood and stumps, woods, crest of Connecticut Hill; same date, slide 32110h. One specimen from moss from rock rim at foot of slope, south side of Taughannock Ravine, Cayuga Lake, N. Y.; taken April 25, 1932, slide 336h1. One specimen from fallen dead wood, beech woods on road 330, north Brookdale (Six Mile valley, south of Ithaca), N. Y.; taken August 20, 1933, slide 3321h.

Except for the Connecticut record, known only from vicinity of the type locality especially places showing Canadian life zone tendencies. Distinctly epixylous.

Euphthiracarus punctulatus (15, p. 250, pl. 40, Figs. 60–65)

This species is related to Pseudotritia by its simple carina, and not broadly rounded rostrum; the rostral bristles are not as curved and depressed as in the type species. It is intermediate in shape of aspis and rostral bristles between the above species and the next.

Material examined: One specimen from rot-pocket in section of trunk of yellow birch, cut about two years previously, near East Village, Monroe, Conn.; taken November 6, 1931, slide 3175h. Twenty-seven specimens from under face of old boards, edge of woods, near East Village; taken August 4, 1932, slide 3230h. One specimen from very rotten log in woods, near East Village; taken August 25, 1932, slide 3245h. Eleven specimens from under face of wood, woodland margin, foot of Indian Hill, along Forest Road, New Haven, Conn.; taken August 25, 1932, slide 3247h. One specimen from leaf mould, small gully on road up from Cayuga Lake between Myers and Norton, N. Y.; taken December 5, 1932, by C. R. Crosby, slide 32111h. One specimen from leaf mould, from under ground hemlock and foot of an elm, on slope, eight feet above ravine bottom, south side of Taughannock Ravine, N. Y.; taken April 25, 1933, slide 337h1.

This extension of range into central New York is complementary to the preceding. It begins to look as if this species were transitional and the preceding were Canadian. Both are predominantly epixylous.

Euphthiracarus flavus pulchrus (15, p. 250, pl. 39, Fig. 59)

Based on a single specimen from a hemlock ravine in central Connecticut, this species now appears to be fairly common in rather dry habitats in unanthropized areas of the northwest corner of the state (see Record of Occurrences).

Euphthiracarus crassisetæ *sp. nov.*

Diagnostic characters: Bristles somewhat short, stout; rostrum high; dorsal face of aspis entirely pocked, down to the usual double carina; rostral bristles short, stiff; vertex bristles long, slightly clavate; pseudostigmatic organs long (in dorsal aspect), curved anteriad and dorsad, with short, clavate head, each edge lined with cilia, thus somewhat resembling those of *Pseudotritia ardua* but distal end more blunt; anterior end of anogenital plates flattened, finely crenulate, bristles II: 2 inserted on transverse plane passing close to I: 2.

Description: Aspis typical for the genus; rib slender but well developed; rim extended to base of rostrum; notogaster amygdaloid, similar in shape to that of *Pseudotritia ardua,* sculptured with pock marks leaving interspaces narrower than the pocks. Grimy individuals have the pocks filled with grit so that the pocks are no longer visible but one sees clusters of granules with interspaces wider than the granule clusters, sculpture extending to edges; dorsal edge of collar somewhat recurved; bristles inserted as usual for the genus; anogenital plates pocked, the three anterior bristles of the genital area concentrated on the flat, finely crenulated area; bristles of anal area inserted much as in *E. flavus* but I: 1 and I: 2 more distant.

Dimensions:	*Male*	*Females*
Greatest 1. of notogaster	0.459 mm.	0.578 mm.
Height of notogaster	0.28 mm.	0.34 mm.
Total length of aspis	0.178 mm.	0.28 mm.
Anterior edge of pseudostigmata to tip of rostrum	0.14 mm.	0.2 mm.

Cotypes: Four specimens from leaf mould from beneath ground hemlock and foot of an elm, eight feet above ravine bottom, south slope of Taughannock Ravine, N. Y.; taken April 25th, 1933, slide 337hl.

Tribe PHTHIRACARINI (15, p. 214)

Phthiracarinæ with ventral plate bowed ventrad, not at all infolded, broad behind anal aperture; anal and genital covers quite

horizontal, or convex, more or less quadrangular, always free from each other, usually with contiguous corners modified in the form of interlocking nubbins, adjacent edges also warped and curved so as to complement; anterior edge of genital covers deeply infolded to form a collar, or enclosing a collarlike accessory plate. For further description see 16, p. 238.

Type: Phthiracarus (21, p. 874).

KEY TO GENERA

1. Anal covers quite flat (often completely retracted into body), their median edge bearing two well spaced bristles 2
1. Anal covers strongly convex, thus prominently protruding beyond ventral plate, and bearing at least three closely spaced bristles along median edge 3
2. Vertex bristles prominent, erect .... *Hoplophthiracarus*
2. Vertex bristles invisible or lying close to surface of aspis .... *Phthiracarus*
3. Anal covers with three closely and subequally spaced bristles along median edge .... *Hoplophorella*
3. Anal covers with four closely and subequally spaced bristles along median edge .... *Steganacarus*

Genus HOPLOPHTHIRACARUS (16, p. 239)

Phthiracarini with anal covers quite flat, their median edge bearing two well spaced bristles (I: 1 and I: 2); vertex bristles prominent, erect.

Type: *Hoploderma histricinum* (3, p. 12, also 16, p. 240, pl. 20, figs. 14 and 15).

Hoplophthiracarus paludis *sp. nov.*
(Figure 10)

Diagnostic characters: Aspis with retracted rim, carina distinct, firm; bristles stout, gradually tapering to a point; notogastral bristles a1 on edge of collar; anal cover bristles II: 2 long, distal end curved backward.

Description: Aspis smoothly rounded in both lateral and dorsal aspects; rostrum in lateral aspect, with rounded blunt end, and constricted, extremely slender rim; rostral bristles short, straight; lateral bristles absent; vertex bristles quite long, curved; pseudostigmata with well-developed dorsal rim, organ clavate, the head strongly bent upward, (figure 10), abruptly and bluntly pointed.

Notogaster rather low, posterior end flattish; collar narrow, lapet poorly developed; bristles a3 on edge of collar, sometimes directed forwards, a1 rather approximate (figure 10); ventral plate bristles on suture; genital covers each with four distinct, subequally spaced bristles, the anterior two insertions with-

out apparent bristles; anterior edge projecting, rounded; anal covers much longer (figure 10); bristles II: 2 inserted on transverse plane passing slightly nearer I: 2 than I: 1; II: 3 in line with I: 1 and I: 2.

Dimensions of a large individual: diagonal length of notogaster 0.42 mm., height of notogaster 0.28 mm., total length of aspis 0.2 mm., anterior edge of pseudostigmata to anterior end of aspis 0.123 mm.

In general aspect, this species most closely resembles *H. grossamni* (16, p. 243, pl. 20, figs. 12 and 13). The only specialized feature is the position of anal cover bristles II: 3.

Material examined: Thirty-seven specimens from sphagnum moss, open bog, Bethany, Conn.; taken June 22, 1932, slides 3220h1 and -h2. Six specimens from grass (or sedge) mat of open bog, same locality and date, slide 3221h4. Fourteen specimens from well decayed white cedar stump, epigeous moss and litter, under young cedars, edge of same bog, same date, slide 3223h. Six specimens from sphagnum moss and sedge from edge of Bingham Pond, Riga Mountain, northwestern Conn.; taken August 6, 1932, slide 3234h1. Twenty-three specimens from sphagnum of open bog, McClean, Tompkins Co., N. Y.; taken October 24, by Norman Davis, slides 3291h and 3294h (cotypes).

Genus PHTHIRACARUS (21, p. 874)

Phthiracarini with the two posterior pairs of aspal bristles prone and usually not discernible; anal covers not conspicuously convex, the bristles disposed in two rows; surface not pocked or coarsely sculptured. For further details see 16, p. 244.

Type: *Phthiracarus contractilis* (21, p. 874.).

The term Hoploderma (19, p. 77) was instituted to supplant the preoccupied name Hoplophora (17, p. 116) and thus by International Rules of Zoölogical Nomenclature takes the same type: *H. lævigata* which is synonymous with the type of Phthiracarus. German acarologists use the term for pitted or rough species with *H. lævigata* (meaning smooth) as type!

KEY TO SPECIES

1. Notogastral bristles longer than anal cover 2
1. Notogastral bristles shorter than anal cover 4
2. Five bristles on mesal rows (not including VP3) 3
2. Six bristles on mesal rows .... *Ph. setosus*
3. Aspis with projecting rim; pseudostigmatic organs short .... *Ph. bryobius*

3. Aspis with no projecting rim; pseudostigmatic organs long. *Ph. boresetosus*
4. Pseudostigmatic organs long; notogastral bristles stout, not gradually tapering to a fine point, six in mesal rows .... *Ph. olivaceus*
4. Pseudostigmatic organs short 5
5. Rostrum projecting beyond rim of aspis 6
5. Rostrum not projecting beyond aspal rim 7
6. Bristles medium long .... *Ph. compressus*
6. Bristles very short and fine .... *Ph. brevisetæ*
7. Rim formed of reflexed edge of aspis; pseudostigmatic organs blunt. *Ph. anonymus*
7. Rim formed of thickened edge; pseudostigmatic organs pointed 8
8. Anterior end of aspis high, angular; notogastral bristles a1 distant from collar .... *Ph. sphaerulus*
8. Anterior end of aspis low, rounded; notogastral bristles a1 on edge of collar .... *Ph. setosellus*

This key does not include *Phthiracarus sarahæ* and *Phth. erinaceus* (see key of 15, p. 235) which were secured from, and are still known only from, Cliff Island, Casco Bay, Maine.

Phthiracarus boresetosus (15, p. 228)

(Figures 15 to 17)

Emended description: I now present figures for this species, and the following additional characteristics: Rostral bristles inserted rather high up, fairly long, strongly curved (figure 15); rostrum without rim; ventral plate without denticles; VP3 not external; genital covers with but three bristle insertions in outer row (figure 16); accessory plate with a short, blunt horn (figure 15); anal cover bristles II:2 inserted just anterior to transverse plane passing through I:2; II:3 not in line with I:1 and I:2 (figure 16).

The pseudostigmatic organ is unique for this tribe (figure 17). I regard it as a primitive form, much resembling a bristle (see also that of Phtiracarulus, and other Protoplophorinæ). The lack of rostral rim and of carina are primitive characters; the presence of accessory plate horn ally it to *Phthiracarus compressus* and *Phth. bryobius.* It is specialized only as to length of bristles, so I consider this species the most primitive of our Phthiracarus.

Material examined in addition to that recorded in the Table of Occurrences: I have two specimens recorded by Ewing as *H. lurida,* from leaf mould from gorge near Lake Keuka, N. Y.;

taken October 30, 1910, by C. R. Crosby, Cornell Univ., coll. lot 370 sub 4.

All these records are from localities in the Canadian life zone or bordering thereon, and chiefly from leaf mould though also occasionally from moss.

Phthiracarus anonymus amicus *subsp. nov.*
(Figures 11 to 13)

Differs from the species in that bristles b2 are closer to b1 than to c1; anal cover bristles II: 1, I: 1 and I: 2 only visible, each considerably longer than the preceding so that I: 2 is much longer than in the species (12) (figure 13). Dimensions of a large individual: diagonal length of notogaster 0.4 mm., height of notogaster 0.26 mm., total length of aspis 0.22 mm., anterior edge of pseudostigmata to anterior end of aspis 0.12 mm.

Specific characters: Rim projecting prominently, formed of the flaring edge of the aspis, not thickened (figure 11); carina distinct but faint; pseudostigmatic organs short, blunt; notogastral bristles a1 on collar; anal covers with posterior half concave in lateral aspect; ventral plate without denticles; accessory plate with horn (figure 12).

Cotypes: Six specimens from deciduous leaf mould, woods, crest of Connecticut Hill, Newfield, Tompkins Co., N. Y., November 25, 1932, slides 32108h2 and -h3.

It is extremely strange, bewildering, to find a species described from, and thus far known only from, the Pyrenes, in the Canadian life zone of New York state. It is also related to the commonest species of northern Europe, *Phthiracarus ferrugineus* (17, figures 26–33).

Phthiracarus compressus (15, p. 232, pl. 36, Figs. 26–29)
(Figure 14)

This species might be mistaken for *Phthiracarus setosellus.* It differs in having the following characteristics: pseudostigmatic organ head usually blunt; aspal carina absent; aspal rim contracted (rostrum projecting beyond it); notogastral bristles a1 distant from collar.

It may also be confused with small specimens of *Phthiracarus sphaerulus* from which it differs in having pseudostigmatic organ head usually blunt; no carina; anterior end of aspis lower, more rounded.

An interesting differential character, heretofore overlooked

is a spoonlike or hornlike process on mesal end of accessory plate of genital covers (figure 12). It is very much more developed in a European species. It is not visible in some aspects or conditions of closure.

I have two specimens from lot 3240 which seem to be hybrids of this species and *Phthiracarus setosellus.* The aspal rim and pseudostigmatic organs are those of *Phth. setosellus* but the bristles are those of this species. Moreover the accessory plate bears the spoonlike process.

The exact shape of the pseudostigmatic organs varies considerably, so I have included a series of free-hand sketches from specimens of one lot (3226h1). Figures above numeral 14 are lateral aspects, figures below it are dorsal aspects. The notogastral bristles may be considerably longer than originally figured.

Material examined in addition to the material recorded in the Table of Occurrences: Two specimens from leaf humus of tussock sedge, alder thicket next to the railroad tracks, North Haven, Conn.; taken September 14, 1932, slide 3262h. Two specimens from leaf and twig litter, and moss from base of alder clumps, same date and locality as last, slide 3263h. Two specimens from pine leaf mould, foot of pine, woods, Pleasant Hill, Etna, N. Y.; taken November 2 (snow on ground), slide 32103h.

It now appears that, although most commonly associated with moss, this species is also to be found on decayed wood and, of course, in leaf litter. The present records show it to extend from the Austral into the Canadian life zones.

Phthiracarus bryobius (15, p. 232, pl. 34, Fig. 19)

(Figures 18 to 21)

Emended description: The color varies from greenish-grey to olive-brown; the length of the bristles varies considerably, the condition originally figured is average; the size also varies a great deal even in the same lot: diagonal length of notogaster 0.42–0.53 mm., height of notogaster 0.26–0.32 mm., breadth of notogaster 0.23 mm., length of aspis 0.21–0.26 mm., anterior edge of pseudostigmata to distal end of aspis 0.11–0.15 mm.; pseudostigmatic organs rather short, distal end rounded, narrower than body of organ (figures 18 to 20); notogastral bristles a1 more approxi-

mate than b1 or c1; ventral plate without denticles but with a shallow notch!; anal covers quite long, all five bristles well developed (figures 18 and 21), II: 2 on transverse plane of I: 1 or very nearly; accessory plate with spoonlike process, much as in *Phthiracarus compressus.*

This species is therefore easily recognized by its very long, fine bristles; long, low, narrow notogaster; short pseudostigmatic organs; faint carina; high, smoothly arched aspis; and horned accessory plate. It is therefore more closely related to *Phthiracarus compressus* than to *Phthiracarus setosellus.*

Material examined in addition to that recorded in the Table of Occurrences: One specimen from drifted oak and maple leaves, dry upland woods, East Village, Monroe, Conn.; taken June 19, 1926, slide 2610o1. One specimen from club moss under snow, upland swamp, same locality; taken February 18, 1922, slide 22ao1. Six specimens from inner layers of well decayed, fallen hemlock branch, hemlock-pine gully, Pleasant Hill, Etna, N. Y.; taken November 3, 1932, slide 32100h.

From these records it is evident that this species is epixylous.

Phthiracarus setosellus (15, p. 231, pl. 33, Fig. 7; pl. 35, Figs. 20–24)

Material examined in addition to that recorded in the Table of Occurrences: Three specimens from bark of ironwood (*Ostrya virginiana*), scraped from an area twelve inches long, four to five feet from the ground, live tree growing in upland swamp woods near East Village, Monroe, Conn.; taken February 13, 1932, slide 326. Two specimens from hickory shag, from base of a healthy, standing tree, in vacant lot, Coscob headland, Conn.; taken April 12, 1932, slide 3212h.

Never as common as *Phthiracarus compressus* this species is found in similar habitats except that it shows a preference for decayed wood. The two records of the preceding paragraph are unusual as it makes the species at least partly arboreal. For hybrids with *Phthiracarus compressus* see under that species. This species is rather closely related to the common European *Phthiracarus ferrugineus* (17, figures 26–33).

Phthiracarus sphaerulus (1; 15, p. 233, pl. 33, Figs. 1–5)

Material examined in addition to that recorded in the Table of Occurrences: One specimen from leaf litter, woodland slope, near East Village, Monroe, Conn.; taken March 31, 1932, slide 328h. Two specimens from leaf mould from gorge near Lake Keuka, N. Y.; taken October 30, 1910, by C. R. Crosby, Cornell Univ. Coll. lot 370 sub 3 (determined as *Hoploderma dasypus* by Ewing). One specimen from under a log, Xenia, Ohio; taken September 14, 1910, by H. E. Ewing.

This strongly epixylous species is also found in Florida (16, p. 245).

Phthiracarus brevisetae (15, p. 225, pl. 33, Fig. 6)

One specimen from ground hemlock litter, south side, lower end of Taughannock Ravine, Cayuga Lake, N. Y.; taken May 27, 1933, slide 3312h2.

Phthiracarus olivaceus (15, p. 228, pl. 34, Figs. 13–18)

Material examined in addition to that presented in Table of Occurrences: Twenty-three specimens from under face of old boards, edge of woods, East Village, Monroe, Conn.; taken August 4, 1932, slide 3230h.

Though this very distinctive species barely extends into the Canadian life zone it is found throughout the Transitional, on decayed wood, and consequently in the litter, and even occasionally in epigeous moss.

Phthiracarus setosus (1, p. 16) (15, p. 226, pl. 34, Figs. 8–12; pl. 36, Fig. 30)

Material examined in addition to that recorded in the Table of Occurrences: One specimen from oak duff, sand ridge northeast of North Haven, Conn.; taken September 20, 1932, slide 3269h2.

This very distinct species, found in only five lots, is even more restricted northward to the Transitional life zone. Its occurrence in Taughannock Ravine, central New York is a surprise.

Genus HOPLOPHORELLA (6, p. 260)

Phthiracarini with coarsely sculptured notogaster; anal covers strongly convex at least mesally, and with only three bristles along median edge.

Type: *H. cucullatum* (8, p. 133, pl. 6, fig. 35).

Hoplophorella thoreaui (15, p. 239, pl. 37, Figs. 40–43)

Material examined: One specimen from sphagnum from Barnum Pond, Franklin Co., N. Y.; taken June 13, 1933, by C. R. Crosby, slide 3331n. One specimen from decayed spruce stump wood (and covering lichen), or moss and lichen of blueberry hummock, side of Bingham Pond, Riga Mountain, northwestern Conn.; taken August 6, 1932, slide 3233h2. Four specimens from sphagnum moss and sedge, edge of same pond, slide 3234h1. Ten specimens from blueberry leaf mould, same locality and date, slide 3235h2, and -h3. One specimen from Rhododendron and oak litter, dry woods, on burn of May 4, 1930, near Bingham Pond; taken August 6, 1932, slide 3231h2.

Genus STEGANACARUS (9, p. 130)

Phthiracarini with coarsely sculptured notogaster; anal covers strongly convex at least mesally, but with four bristles along median edge.

Type: *H. anomala* (2, fasc. 6 : 5).

Steganacarus striculus diaphanus (15, p. 236, pl. 37, Figs. 33–39)

This is a very variable species in respect to size, development of aspal ridge, shape of rostral bristles which may be nearly straight to strongly curved or even bent, and position of notogastral bristles a1 which may be on edge of collar to half length of bristle behind it. Although specimens from southern Connecticut seemed constant in these characteristics, specimens from the northwestern corner of that state show considerable variation, and I fail to find correlations between any two characters. Specimens from the type locality of the species (Regensburg, Germany) are constant in having slightly curved rostral bristles and

notogastral bristles a1 inserted on edge of collar. Specimens from Strasbourg have rostral bristles sharply bent and held close to face of rostrum, and notogastral bristles a1 distant from collar. The rostrum is quite high. Thus there seem to be distinct subspecies in Europe. It may be that specimens from typically Canadian localities will show constancy of these characteristics, and that my northern localities are in a tension zone. Some specimens from Taughannock Ravine, central New York state, have the anal cover bristles with a wide space between bristles 1 and 2 (slide 337h1).

Material examined in addition to that recorded in the Table of Occurrences: Seventeen specimens from coarsely foliose to fruticose lichens and Selaginella growing on large boulders and ledges, a short way up south side of Sage's Ravine, northwestern Conn.; taken August 6 (dried August 16), 1932, slide 3238h1. One specimen from sphagnum of bog, McClean, N. Y.; taken October 24, 1932, by Norman Davis, slide 3291h. Seven specimens from moss from foot of tree on south slope of gully, Pleasant Hill, Etna, N. Y.; taken November 3, 1932, slide 32102h. Twenty-five specimens from pine leaf mould of preceding spot and date, slide 32103h. Two specimens from lower, mucky layer of sphagnum (below the upper frozen layer), swale below road below wooded ridge of Connecticut Hill, Newfield, Tompkins Co., N. Y.; taken November 25, 1932, slide 32107h. Sixty-eight specimens from pine leaf mould from base of tree, wooded crest of Connecticut Hill, same date, slide 32109h1 and -h2. Two specimens from epigeous moss and lichens from old wood and stumps, same locality and date as last, slide 32110anh.

Judging from these numerous records this species is most at home in resinous leaf mould. It may be that the eggs are laid inside the leaves and the immature animals eat them out.

Retrospect

Phthiracarus brevisetae, known from but two specimens from two collections in Connecticut (15, p. 225), was not again secured in that state but one specimen turned up from central New York. This species is the enigma of the group. In the state of Connecticut, where most of the collecting has been done, there are eighteen

species and one subspecies. It is possible that *Oribotritia banksi* may yet be found along the southern edge of the state in warm pockets, possibly at the eastern end. The new material shows how restricted are some species of this group. For instance *Hoplophthiracarus paludis* was obtained only from sphagnum bogs (in New York and Connecticut). In southern Connecticut *Phtiracarulus leavis* was found only in a sphagnum bog, though more generally in the northern part of the state.

Five or six species per quart of litter are quite normal. Seven species were secured from deciduous (32108), Rhododendron-oak (3240), blueberry (3255), pine (3257), and ground-hemlock (*Taxus canadensis*) (337) litters, as well as moss (3237, 3234), eight species from another lot of Rhododendron-oak (3232) and ground-hemlock (3312) litters, and nine species from hemlock litter (3236). Although eleven species were secured from one lot (3250) the material included leaf-mould from under a Tamarack and its neighboring blueberry bush as well as epigeous moss and sphagnum from between the two (in a Tamarack swamp). The lot may have included more than a quart of litter but all the material came from an area of nine linear feet. The species making up these lots vary locally. One cause for this variation may be the presence or absence of a well-decayed twig or bit of wood.

Of further interest are the three species associated in sphagnum moss of open bogs (*Phtiracarulus laevis, Pseudotritia simplex* and *Hoplophthiracarus paludis* (3220). The same three species were found in pure growths of *Carex trisperma billingsii* of the same bog (3221). This combination was not found in sphagnum of a New York bog (3291). In fact *Phtiracarulus laevis* was not found in central New York though *Pseudotritia simplex* was found in small numbers.

There is reason to believe that latitude tends to cause changes in habits or habitats in the same species. In my work on the Galumninae, I have already pointed out that the same species (usually different subspecies) has entirely different habitat preference in Europe than in North America. Another distributional observation is that some of the Oribatoidea are very local, so that lots can be taken from many spots in the same locality before all the species are obtained.

The young of any of these species are rarely found by the usual collecting method. This is undoubtedly due to their being situated inside of decayed wood or other plant tissues from which they cannot emerge without suffering immediate desiccation. Moreover their legs are not developed for perambulation. I am therefore certain that the determination of the niches of the young will prove of much greater ecologic interest than that of the adults which may wander widely in search of mates. After surveying the distribution records of this and the preceding report (15), I am satisfied that most of the adults are generally distributed over the forest floor but they are numerous where the preferred food of the immatures is abundant.

It is of particular interest that although one or two species of Galumninae have been introduced from Europe to the neighborhood of some of our cities, as far as known no Phthiracaridae have been so introduced—unless *Pseudotritia ardua* be so regarded, though I consider it a holarctic species too variable to establish clean cut geographic races.

The small, pale colored *Steganacarus striculus diaphanus* is found in the greatest numbers and most generally. *Pseudotritia ardua* and *Pseudotritia simplex* are the most resistant to desiccation and consequently found in the driest habitats, as sand barrens, vegetated sandy beaches, on frequently burned land, and on cultivated land, while other species of the family are absent. This difference may be due to one habit, namely, laying eggs in the soil or in decayed roots. If species of Phthiracarus lay their eggs in dead leaves or dead wood above ground, the eggs would be killed by the next fire and both adults and immatures would be eliminated from the area of the fire, while the eggs and young of the Pseudotritias, safe in the cool, moist soil would be unaffected by the litter consuming fire. Species inhabiting dead wood will survive if the fire is swift enough or dead wood is wet enough to remain unburned. I have found such partly burned sticks on burned woodlands, and with a fauna thereon. A comparison of lots 3231 and 3232 shows that a fauna becomes rapidly established two years after a fire. It is possible, however, that the spot from which I secured the samples was near enough to the road to have become moistened by the fire-fighters.

RECORD OF OCCURRENCES

	Ps. ardua	*Ps. a. curticephala*	*Ps. simplex*	*Eu. f. pulchrus*	*Ph. compressus*	*Ph. bryobius*	*Ph. setosellus*	*Ph. sphaerulus*	*Ph. boresetosus*	*Ph. olivaceus*	*Ph. setosus*	*S. diaphanus*
Connecticut												
3247 Under face of wood, wood margin, foot of "Indian Hill", along Forest Rd., New Haven, Conn., Aug. 25, 1932					2			1		1		
3226 *Selaginella apus* and epigeous moss of upland swamp, especially from the more elevated clumps of earth, among skunk cabbages, East Village, Monroe, Conn., July 7	30				30		3				3	2
3229 Old fence rails branches, and chips, old orchard, East Village; Aug. 4.	5					1	1	14		22		
3245 Very rotten log in mesic hardwoods, East Village, Aug. 25 *			7		3		1	1				4
3250 Leaf mould, sphagnun and other mosses about foot of an eight inch Tamarack and under blueberry bushes of a Tamarack swamp, head of valley at foot of Rabbit Hill, Warren, Conn. Aug. 26*	42		70		46		1	10	10	1	83	442
3252 Pine leaf mould of fernery, north side of Howland Mt., roadside, South Cornwall, Conn., elev. 1300ft. Aug. 26	1						1		11	1		12

RECORD OF OCCURRENCES *(Continued)*

	Ps. ardua	*Ps. a. curticephala*	*Ps. simplex*	*Eu. f. pulchrus*	*Ph. compressus*	*Ph. bryobius*	*Ph. setosellus*	*Ph. sphaerulus*	*Ph. boresetosus*	*Ph. olivaceus*	*Ph. setosus*	*S. diaphanus*
Connecticut												
3253 Moss on rocks along trickle (possibly also rotten roots, etc.), Calhown Pines, Cornwall, Conn., Aug. 26			1		48	2	6		60			80
3254 Epilithic moss (possibly old wood also), top of slope, same loc. and date.			3			6		3	6			90
3255 Well decayed fallen boles and their moss, same loc. and date		14	1		4					1		26
3257, 3259 Pine leaf mould (no moss), same loc., dried Sept. 6		6	169	2	9				22	1		274+
3236 Hemlock leaf mould up Wachocastinook Creek, (below burn), dried Aug. 13	9	1		3	8		10	5	6	1		403
3237 as 3236 but epigeous moss and old stump moss under Rhododendron, dried Aug. 15	7	2		2	2		2	7			1	24
3232 Rhododendron and oak litter, dry woods, near Bingham Pond, Riga Mt., northwestern Conn. Aug. 6, 1932*	11			12	10		3		9			50
3231 Same but from across road on burn of May 4, 1930*	38		12		10		10		19	1		126

RECORD OF OCCURRENCES (*Continued*)

	Ps. ardua	*Ps. a. curticephala*	*Ps. simplex*	*Eu. f. pulchrus*	*Ph. compressus*	*Ph. bryobius*	*Ph. setosellus*	*Ph. sphaerulus*	*Ph. boresetosus*	*Ph. olivaceus*	*Ph. setosus*	*S. diaphanus*
Connecticut												
3233 Decayed spruce stump and covering lichens, mosses and lichens of blueberry hummock, side of Bingham Pond, Aug. 6*	4		41		11	1	2			3		3
3234 Sphagnum and sedge, edge of same pond*	13		5		11	1						1
3235 as last but blueberry leaf mould, dried Aug. 12*	24	1	4		69			1				10
3239 Well decayed fallen hemlock hole bearing a little lichen, half-way up south side of Sage's Ravine, northwest Conn., Aug. 6 (dried Aug. 17).*		42		4	2	1						2
3240 Laurel litter, same spot, dried Aug. 22*	12		17	29	6		3					224
3241 Dry hemlock mould, moss and Selaginella, on cliffy rocks, same spot, dried Aug. 23*				2	6							85

RECORD OF OCCURRENCES (*Continued*)

	Ps. ardua	*Ps. a. curticephala*	*Ps. simplex*	*Eu. f. pulchrus*	*Ph. compressus*	*Ph. bryobius*	*Ph. setosellus*	*Ph. sphaerulus*	*Ph. boresetosus*	*Ph. olivaceus*	*Ph. setosus*	*S. diaphanus*
New York State												
3289–90 Pine leaf mould and duff, foot of pine tree, east slope of Pleasant Hill, Etna, N. Y. Oct. 15*		4	3						1			144
32102 Moss, foot of tree on west, wooded slope of hemlock-pine gully, same loc. Nov .3	2				2							7
3295 Epigeous moss, swamp floor, Ringwood, Tompkins Co., N. Y. Oct. 22	3		2		24			5		3		34
3296 Epigeous moss, pool margin, same loc. and date	1						3	2	2	6		1
32108 Deciduous leaf mould woods on crest of Connecticut Hill, Newfield, Tompkins Co., N. Y. Nov. 25*	3				1		3	15	17			32
32109 Pine litter, base of pine tree, same as last*			7						1			68
32110 Epigeous moss and lichens from old wood and stumps, same loc. and date*					1				1			2

RECORD OF OCCURRENCES (*Concluded*)

	Ps. ardua	*Ps. a. curticephala*	*Ps. simplex*	*Eu. f. pulchrus*	*Ph. compressus*	*Ph. bryobius*	*Ph. setosellus*	*Ph. sphaerulus*	*Ph. boresetosus*	*Ph. olivaceus*	*Ph. setosus*	*S. diaphanus*
New York State												
32111–13 Deciduous litter, small gully along road up from Cayuga Lake between Myers and Norton; Dec. 5, coll. by C. R. Crosby*	25						1	12			7	17
336 Moss from rock rim at foot of slope, south side of Taughannock Ravine, Cayuga Lake, N. Y. April 25*	3						6	7		1		2
337 Leaf mould from under ground hemlock, and from foot of an elm, on south slope 8 ft. above bottom of same ravine, April 25*	23						5	4			21	8
3310 Ground hemlock litter on ridge along bottom of same ravine, May 27	3							5			2	7
3312 Ground hemlock litter south slope, lower end same ravine, May 27*	18				1		2	12		3	6	2
3321 Fallen dead wood in beech woods on road north of Brookdale (up Six Mile Creek from Ithaca) N. Y. Aug. 20*							1	7		6		

* Other species are recorded in the text.

Although interspecific hybrids are fairly common among some of the European species of Phthiracarus (17), in our northeast, but one case of hybridization has been observed, that between *Phthiracarus compressus* and *Phthiracarus setosellus*.

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PLATE IX

Phtiracarulus laevis sp. nov.

Figure 1. Lateral aspect, legs and mouth-parts omitted; ratio × 200.
Figure 2. Ventral aspect, legs and mouth-parts omitted; ratio × 200.
Figure 3. Genital cover; ratio × 440.
Figure 4. Ventrolateral aspect of nymph III; ratio × 200.
Figure 5. Ovipositor, extruded; ratio × 330.

Protoribotritia canadaris sp. nov.

Figure 6. Pseudostigmatic organs, that above numeral is lateral aspect, that below is dorsal aspect; ratio × 440.
Figure 7. Dorso/ventral aspects, legs and mouth-parts omitted; ratio × 150.

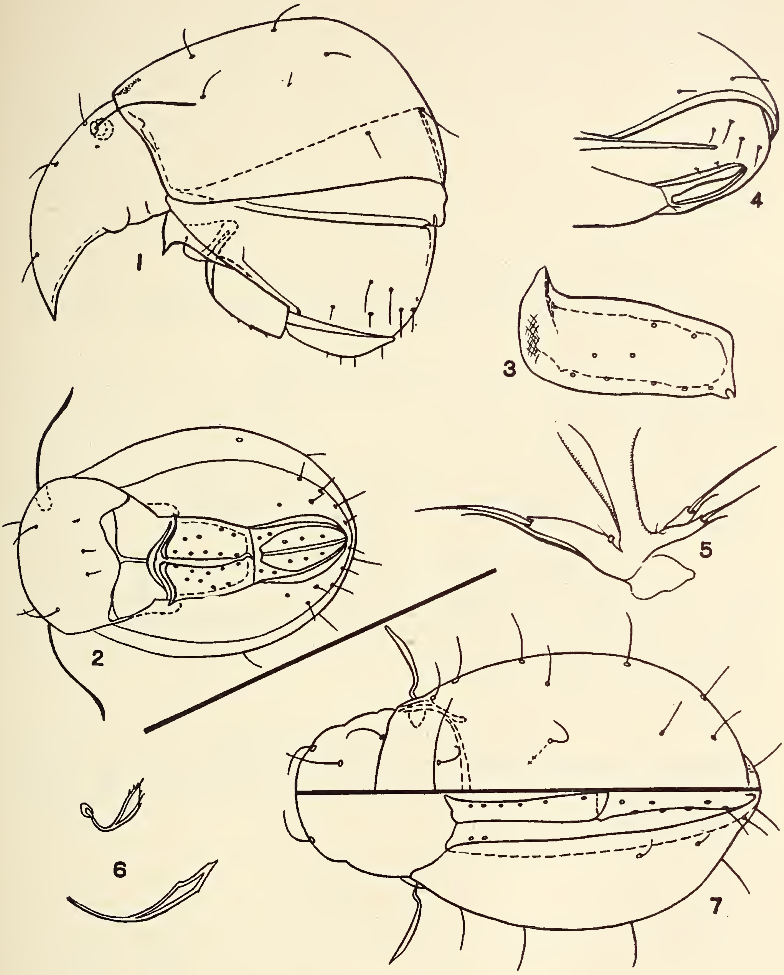

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PLATE X

Protoribotritia canadaris sp. nov.

Figure 8. Lateral aspect, legs and mouth-parts omitted; ratio × 150.

Pseudotritia ardua (18)

Figure 9. Ovipositor and genital suckers extruded, animal facing to the right; ratio × 200.

Hoplophthiracarus paludis sp. nov.

Figure 10. Dorso/ventral aspects, legs omitted; ratio × 120.

Phthiracarus anonymus amicus subsp. nov.

Figure 11. Anterior end of aspis; ratio × 120.

Figure 12. Anterior end of genital covers, including accessory plate horn; ratio × 120.

Figure 13. Anal cover; ratio × 120.

Phthiracarus compressus (15).

Figure 14. Pseudostigmatic organ head; figures above numeral are lateral aspect, those below numeral are dorsal aspect, the lower two are unusual, lateral aspect; free hand.

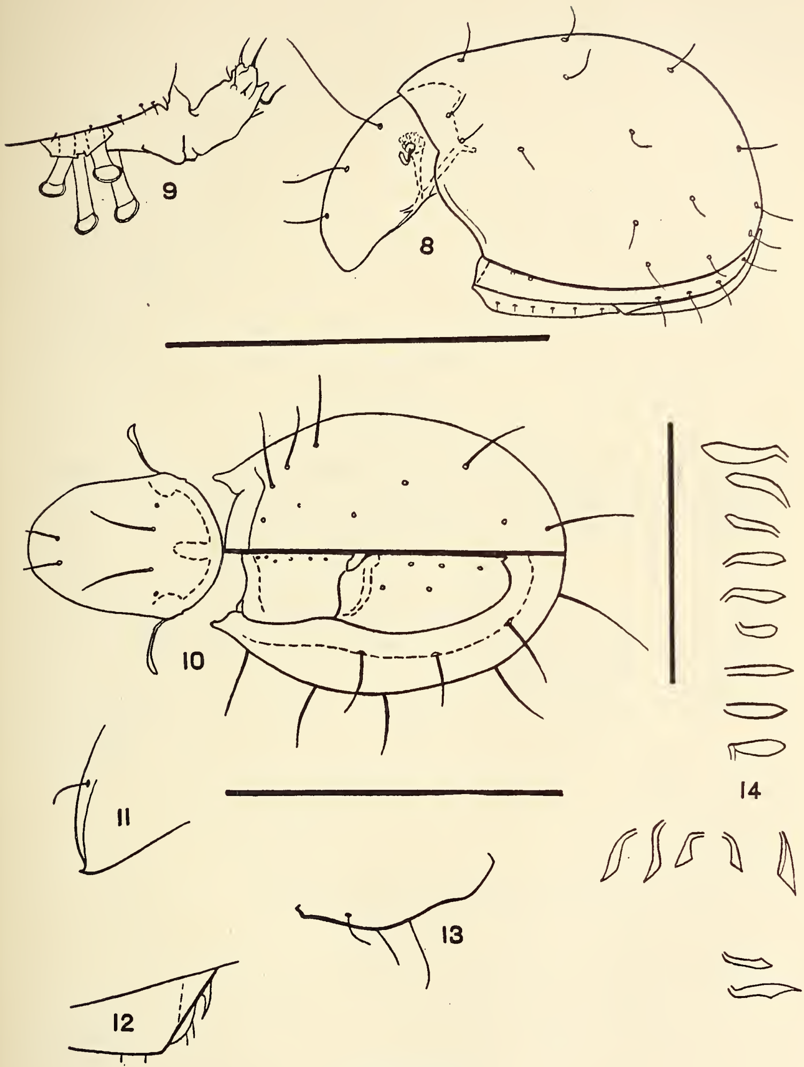

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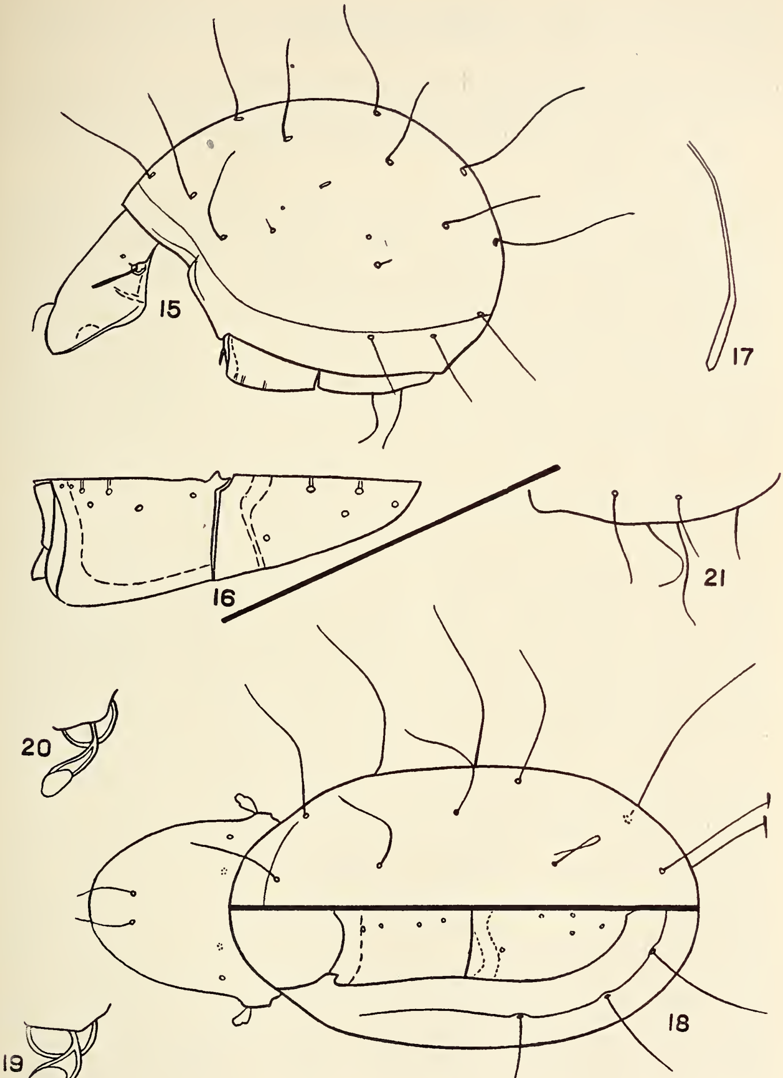
PLATE XI

Phthiracarus boresetosus (15)

Figure 15. Lateral aspect, legs and mouth-parts omitted; ratio × 150.
Figure 16. Accessory, genital and anal plates; ratio × 200.
Figure 17. Pseudostigmatic organ, dorsal aspect; ratio × 440.

Phthiracarus bryobius (15)

Figure 18. Dorso/ventral aspects, legs omitted; ratio × 120.
Figure 19. Pseudostigmatic organ, lateral aspect; ratio × 440.
Figure 20. Same, another.
Figure 21. Anal cover; ratio × 200.



BOX-MITES

BOOK NOTICE

Strange Insects and Their Stories. By A. Hyatt Verill. 8vo., cloth, 205 pp., jacket and frontispiece in color, 4 full page illus., and 100 text cuts by author. Boston, L. C. Page & Co., 1937. $2.50.

This is one of the books issued within the "Strange Stories from Nature Series," of which other volumes of similar scope have appeared or are now in course of preparation. In this latest one the author undertakes to deal in a nontechnical way with insects, their life histories and habits, and with especial emphasis on the comparatively little known peculiarities and apparent idiosyncrasies of some of the comparatively well known forms. A general introductory discussion of the whole subject is followed by sections dealing specifically with such topics as insects as man's greatest foes and firmest friends; insect artizans; insect ogres; the life of the locust; boatmen, fishermen and pirates; insect gems; the Smyrna fig wasp in its relation to fig culture; insect bugaboos; some giants of the insect world; brownies of the insect world; how insects play hide and seek; insect undertakers; insects that carry lanterns; some incredible ants; insects used as food; and differences between insects and nearly related forms. There is practical information on findings, collecting, rearing and preserving insects. Only insects appear to have been included which an average person might observe, either in the temperate zone or in the tropics. The author has selected types, rather than species, whose odd habits or unusual characteristics would make their study of more than passing interest to the average reader. Another book already issued within this series by the same writer treats of shells, while others now in preparation will deal similarly with birds, fish, reptiles and fossils. Mr. Verill is also author of several other works on various phases of natural history, notably "The Incas' Treasure House," and "The Deep Sea Hunters."

J. S. W.

MANTISPIDÆ PARASITIC ON SPIDER EGG SACS

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Incidental to observations on insect parasites of spiders the following is thought worthy of note. There emerged from the egg sac of the funnel web weaver, *Agelena naevia* Walckenaer, a female specimen of *Mantispa fusicornis* Banks.[1] This species was first described in 1911 from Florida, though there are specimens in the collection of the Museum of Comparative Zoology which have been taken from as far north as Virginia. It has not, to my knowledge, been again recorded in the literature and little is known about its distribution or habits.

Figures 1 and 2 illustrate the external characters of the specimen, a description of which is given herewith. Length over all to tip of wings behind, about 22 mm. Head about 2.5 mm. wide, brown marked with black. A median longitudinal black line on clypeus and labrum. Antennæ 3.2 mm. long, separated at base by a distance about equal to length of scape; the latter light, the pedicel brown, and the 28 more or less similar segments of the flagellum black. Maxillæ reddish with long 5-segmented palpus. Labial palpus short, 3-segmented.

Prothorax tubular, 4.3 mm. long, transversely wrinkled, expanded cephalad, and rebordered along anterior edge. Mostly grayish brown, darker on expanded portion in front of the pair of pronotal tubercles. Extending back along the mid-dorsum is a thin, black stripe widening somewhat in front of the mesothorax, and a less conspicuous black stripe lies ventrolaterad on each side.

Pterothorax mostly black, with a pair of yellow bands on the mesoprescutum and mesoscutum, and a less distinct pair on the metascutum, these diverging posteriad and joining the yellow bases of fore and hind wings. The pleural areas with distinct an- and katepisterna, but a distinct suture demarcating the an- and

[1] Identified with the aid of Professor Nathan Banks of the Museum of Comparative Zoology.

katepimeron present only on the metathorax. The location of this suture on the mesothorax is marked by a ridge. Abdomen black with splashes of reddish brown.

Prothoracic leg raptorial, the coxa 4.5 mm. long, yellowish gray, with a suggestion of a division in the proximal third. Femur dark brown, enlarged, with a spur equal in length to the width of the segment at that point arising from the medial surface, and with many short teeth extending to the distal end. Tibia and tarsus dark brown, the latter 5-segmented, and ending in a single smooth claw. Meso- and metathoracic legs ambulatorial, similar in appearance and in size, except that the tibia of the latter is almost $1\frac{1}{2}$ times the length of that of the former. Coxæ brown, other segments yellowish gray, tip of tarsus black and ending in a pair of 5-toothed claws and a broad pulvillus. Third tibia lacking the "sillon longitudinal," or *linea impressa,* of Navás (1925).[2]

Fore wing 17 mm., and hind wing 14 mm. long, clear except for reddish brown pterostigma. Venation of right wings as indicated in figure 2, but left wings differing from these in a number of details. In the fore wing the most important difference is the absence of a cross-vein between the 1st and 2nd cells R_1 so that there is one long and one ordinary cell, instead of three cells. In the hind wing a cross-vein is present dividing into two the very long cell (R?) proximad of the 1st cell R_1. These and other types of variations have been fully discussed by Kuwayama (1925). This author pointed out the need for caution in diagnosing genera on the basis of wing venation, which is apparently quite variable in the Mantispidæ.

The spider was among those collected by Mr. R. B. Brown near Albion, Mich., on Sept., 17, 1936 and taken to New Haven, Conn., the next day, to be later used in some morphology studies at Yale University. The spider was confined in a cylindrical glass container with a cover, which, however, to allow the passage of air was raised slightly by inserting a piece of string between it and the container. The spider laid its eggs on about Sept., 20 and was killed for study a few days afterward. No spiderlings had yet emerged on October 15, and the egg sac was not looked at again

[2] This character is probably not present in the Mantispidæ. At least it was not present on specimens of *Mantispa interrupta* Say, *M.* (*Climaciella*) *brunnea* Say, and *M. viridis* Banks which I had an opportunity to examine.

until November 8 when the parasite was found lying dead on the bottom of the container. The white egg sac was seen to have within it a greenish yellow, oval cocoon (Fig. 3). This cocoon was made of loosely woven threads and was 8.4 mm. long by 6.9 mm. wide. Both egg sac and cocoon were perforated by a more or less circular hole 3.3 mm. in diameter through which the parasite had emerged. Also in the container, but outside of the cocoon, were the exuviæ of the pupa or nymph. Only the occipital and pronotal regions were split, indicating the site of emergence of the imago. The wing pads extended back to about the fourth abdominal segment. It is interesting to note that in the pupa the prothorax and prothoracic coxæ are not elongate as in the imago, but hardly longer than the corresponding structures on the pterothorax (Fig. 4). Moreover, the trochanter is hardly apparent, while a proximal, patella-like division of the tibia is very conspicuous. Brauer (1855), in describing the pupa of *Mantispa pagana* Fabr., had called attention to the fact that the prothorax is only half the length of that in the imago, but the reader is given to understand that the prothoracic legs are the same as in the imago. Unfortunately, in his figures these legs are not clearly discernible.

Discussion. The circumstances surrounding the development of this parasite seem very peculiar, especially when viewed in the light of the classical investigations of Brauer (1869) on the European species, *Mantispa styriaca* Poda. For many years his was the only case known, and all the standard entomology texts give Brauer's account of the life history as typical for the group. Two points are emphasized in his account: first, the sacs of only certain species of Lycosidæ[3] are attacked, and second, the young campodeiform larvae, despite the fact that they can move about actively, do not feed or enter the spider egg sacs until after a period of eight months hibernation. However, Brauer himself had found a *Mantispa* larva in the lenticular sac of a *Thomisus* (crab spider), and he also referred to Rogenhofer's rearing a specimen from the

[3] *Sensu latiore.* Brauer lists the following as favorable material for rearing the *Mantispa: Lycosa inquilina, Arctosa allodroma* (= *cinerea*), and *Dolomedes* (the latter belonging to the Pisauridæ). All of these have white spherical egg sacs. He states definitely that the lenticular green egg sacs of *Lycosa fluviatilis* (= *Pardosa agricola*) are not attacked.

egg sac of a *Clubiona,* though he thought these were exceptions. Moreover, Poujade (1898) gives *Drassodes hypocrita* Simon as the host of *M. stryriaca,* and six of the same species were also reared from drassid egg sacs by Main (1931). It seems probable therefore that this species is polyphagous.

For American species notes on the eggs, young larvæ, and habits are given by Smith (1934) for *interrupta, sayi,* and *brunnea;* by Hungerford (1936) for *interrupta;* and by Hoffmann (1936) for *brunnea* var. *occidentalis.* To date none of these larvæ have been successfully reared to maturity, but Smith records the emergence of a pupa of *interrupta* from the egg sac of the jumping spider, *Dendryphantes militaris.* Dr. G. W. Barber, of the New Haven laboratory of the U. S. D. A. Bureau of Entomology and Plant Quarantine, informs me that he has observed a female of *interrupta* ovipositing on a leaf, so that it is entirely possible that this species may also be parasitic on other attids, clubionids, and thomisids, etc., which attach their egg sacs to leaves.

It is evident that in the case of *M. fusicornis* the larva did not hibernate. It is still a question as to where it came from, and there are two possibilities. It either crawled through the narrow slit into the spider's container at New Haven, or was carried from Michigan hidden among the hairs on the spider's body, only to leave it for the egg sac after the latter was made. Even if the larva entered the egg sac on the same day it was made, less than 48 days were needed to complete its development to the imago, (assuming that the adult stage was attained the day before it was found dead). In Brauer's case the larvæ did not pupate until 50 days after entering the egg sac, and the adult stage was not attained until over four weeks later.

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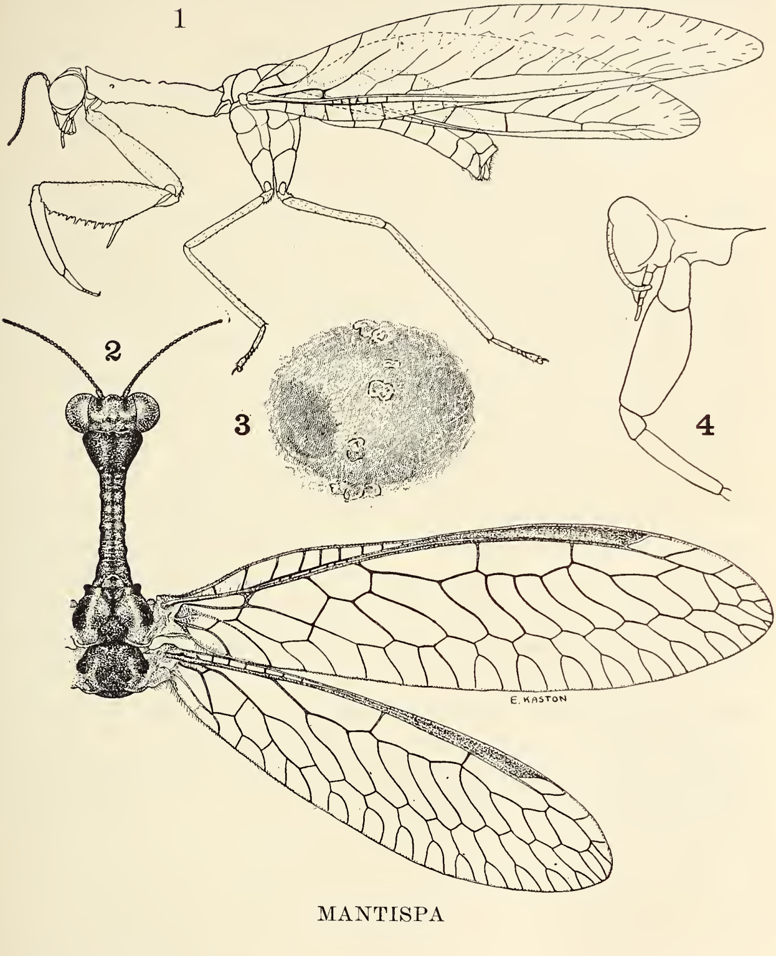
PLATE XII

Figure 1. Lateral aspect of *Mantispa fusicornis* ♀ ; wings in normal position.

Figure 2. Dorsal aspect of head, thorax, and right wings.

Figure 3. Cocoon from which pupa emerged. A few empty egg shells of the spider are adhering to the surface.

Figure 4. Lateral aspect of the pupal head, prothorax, and part of prothoracic leg.



MANTISPA

BOOK NOTICE

Lac Cultivation in India Being a Second and Revised Edition of "A Practical Manual of Lac Cultivation" By P. M. Glover, published in June, 1931. By P. M. Glover. The Indian Lac Research Institute. Namkum, Ranchi, Bihar, India, 1937, viii + 147 p., 16 pl., incl. 2 col'd, 9 fig. Price Rs. 2/–.

In the June 1935 issue of THE JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, there was reviewed briefly a report of the Indian Lac Research Institute. Now there has appeared, "a practical manual of lac cultivation" by Mr. Glover, which should be of interest to American entomologists, if not in a practical way, at least as indicative of the entomological problems in other parts of the world. The present work includes the practical results that were developed at the Institute during the past six years and brings up to date certain sections of the first edition. There are twenty-two chapters, covering an account of the lac insect, lac production, lac prices and cultivation, propagation, pruning and inoculation of lac hosts, the manufacture of shellac, the use of various lac hosts, lac cultivation in various countries, enemies of lac and lac host trees, a list of host trees, a glossary of terms, and a bibliography. Mr. Glover has written a detailed specific and comprehensive manual of lac cultivation, which should be invaluable to the educated cultivators of lac in India and elsewhere. After reading Mr. Glover's book, skipping only the list of host trees and the glossary, I have a better appreciation of the lac industry and a more orderly knowledge of its entomological aims, accomplishments and difficulties. H. B. W.

A STUDY OF THE ELLIPTICAL GOLDENROD GALL CAUSED BY GNORIMOSCHEMA GALLÆSOLIDAGINIS RILEY

By George W. Barber

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INTRODUCTION

The insects, beset on every hand in nature by enemies—animal and plant, predacious and parasitic, and dependent upon the vicissitudes of the physical environment, have developed many interesting, surprising, and curious means of protection against these decimating factors. Few of the protective adaptations are more wonderful or less understood than those of the gall-forming insects, which, by one means or another, cause the host plants to build them habitations out of their plant substance, wherein the insects may feed in comparative security.

A host of insect species attacking many species of plants cause galls to develop on roots, stems, branches, twigs, leaves, or other parts, and they frequently become numerous enough to cause severe injury to the plants attacked. These galls form one of the curiosities of any countryside, sure to attract the attention of the naturalist.

While the galls of some insects are very elaborate in structure, one of the simplest may take the form of a more or less pronounced swelling of the stem, resulting from feeding by the insect therein. Some of the galls inhabited by the gelechiid moth *Gnorimoschema gallæsolidaginis* Riley appear to be of this type, the stem being hollowed out for a certain distance vertically and but little swollen. Other individuals of this species inhabit better defined galls that are sometimes nearly or quite globular.

For years the writer has observed these goldenrod galls in various localities and has been interested in the variation that they showed, but he had not found them in numbers sufficient for a study of this variation. However, in 1929, in a locality near Richmond, Va., a large infestation of the insect was observed. In one

roadside spot every second or third stalk of goldenrod bore one or more galls of this species, and a sufficient number could be obtained for study. Since these galls varied greatly in size, an effort was made to determine the probable reason for the variation, whether it extended to the insects inhabiting the galls, and in what way such variations were related. A further effort was made to determine what degree of protection the gall formation afforded the insect habitant.

HABITS AND LIFE HISTORY OF THE GALL MAKER

In central Virginia the galls begin to appear on the partly grown goldenrod plants late in June or in July, but development of the insect within the galls is slow. By the middle of August the larvæ become full grown and begin to pupate, and the moths emerge during October, there being a single generation annually. Leiby[1] found that the eggs of *G. gallæsolidaginis* are deposited in the fall on goldenrod stems or leaves. These hatch the following spring, and the young larvæ migrate to new goldenrod shoots in the vicinity, crawl to the buds, enter them from the side, and bore downward in the stems for a short distance. Here the larvæ settle and feed on the inner walls of their burrows. The progress of emergence in the autumn of 1929 is indicated by the following records: From the 1st to the 4th of September 2,000 galls were collected but from none of them had the moths emerged; on September 30, when 500 galls were collected, moths had emerged from only 2.6 per cent of them; on October 15 and November 5, however, from 500 galls collected on each date, moths had emerged from 39.8 per cent and 100 per cent, respectively.

During the time that the larva is feeding, no opening is seen in the gall and no communication with the outside is apparent. While this condition is admirably suited to the needs of the larva, as it permits the latter to feed and grow unhurried by fear of danger, this shelter, unless there were special provision for escape from it, would prove to be a tomb for the moth, which lacks suitable mouthparts for biting through the plant tissue forming the gall. Providing for the escape of the moth is the last act of the larva

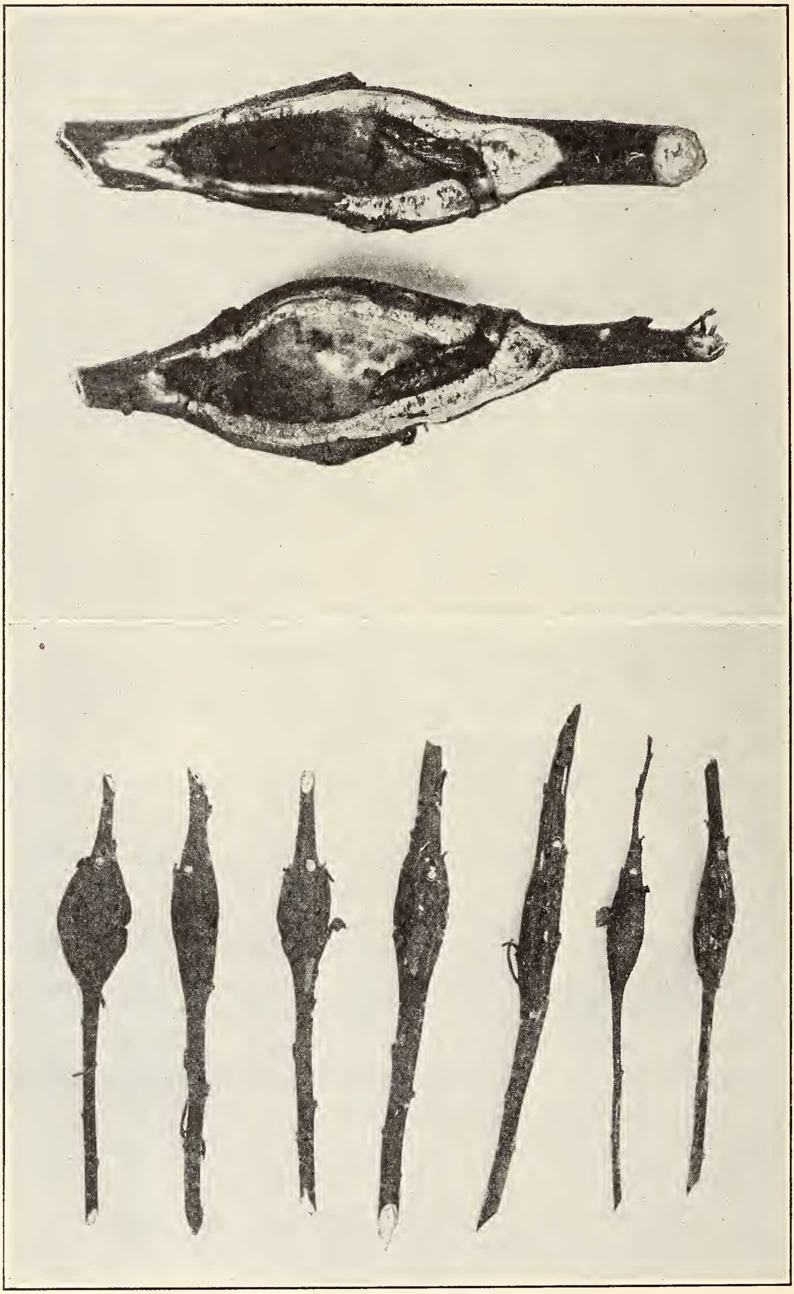
[1] Leiby, R. W., Biology of the goldenrod gall-maker *Gnorimoschema gallæsolidaginis* Riley. Jour. N. Y. Ent. Soc. 30: 81–94, lilus. 1922.

before pupating, and this provision is perhaps among the most remarkable to be found among insects.

The larva, which seemingly feeds upon the inner wall of the gall, maintains a neat and thoroughly sanitary habitation. All fecal matter is deposited in the bottom of the gall and covered with silk. When the larva is through feeding, a heavier layer of silk is applied to the piled fecal matter and to the entire inner surface of the gall. A tunnel is now gnawed from the uppermost point in the gall toward the outside, not entirely through the wall, as usually described in literature, but only partly through. To leave the burrow open, or even covered with silk, would expose the retiring insect to too great danger from enemies that could easily enter. Some time before the burrow has reached the surface, the larva discontinues gnawing, covers the burrow with silk continuous with that laid down on the inner wall of the gall, and proceeds to the most delicate task of its life. It cuts a groove continuous with the wall of the burrow, through to the outside of the gall, leaving undisturbed the contained circular section of the wall. The groove is directed slightly away from the center as the outer surface of the gall is approached, making the diameter of the carved-out cylinder to increase from within outward. The resulting plug is entirely severed from the surrounding wall of the gall, and the groove appears on the outside as a circle.

The last detail of its chamber having been completed, the larva retires to the hollow of the gall to pupate. The emergence burrow is securely closed by a structure which is a true "bung," entirely separated from the rest of the wall of the gall. From the inside a mere touch will force the plug out of the emergence burrow, but it cannot be forced in from the outside except by considerable pressure. Frequently, as the plant ripens and the stalk dries, the plug assumes a lighter color than the surface of the gall proper and is easily seen, as in figure 2. Enough light enters through the groove separating the plug from the gall to direct the moth toward the avenue of escape provided for it.

The plug, or "stopper," was always present in galls containing pupæ, and it was always suitable for the emergence of the moths; for in no case, among the hundreds of examples of the gall studied, did a moth fail to gain freedom by this means. (Fig. 1.)



Above—FIGURE 1.—Goldenrod galls split to show hollow interior, the piled excrement at the base, the emergence plug, and the pupæ. *Below*—FIGURE 2.—A series of goldenrod galls showing the position and discoloration of the plugs.

Among insects, prescience in the provision by one stage for the welfare of a succeeding stage is a common enough phenomenon, but in this instance the arrangements are much more complete than usual. Many boring insects make provision in the larval stage for the escape of the mature insect. In the goldenrod ball gall, caused by the trypetid fly *Eurosta solidaginis* Fitch, the maggot occupies a small cell surrounded by a greatly thickened wall. The insect passes the winter as a full grown maggot within the gall, no provision having been made thus far for the emergence of the delicate fly. In spring an emergence burrow is constructed by the maggot which leaves intact a thin cap partially cut through the outer wall of the gall. This the fly is able to push away as it seeks its freedom.

Among Lepidoptera, the full grown larva of *Diatrœa crambidoides* Grote bores to the lowest point in the stalk of the corn plant in which it has fed, and here, some distance below the surface of the soil, it hibernates. In spring the larva becomes active, retraces its burrow, or gnaws a new one upward through the stalk to a point a few inches above the surface of the soil, and there gnaws an opening through the wall of the stalk to the outside, closes the opening with silk as a protection, and retires to pupate.

These two examples illustrate the usual way in which many larvæ feeding in the interior of plants provide for the escape of the adults. As compared with *Eurosta* or *Diatrœa,* it may be seen that *Gnorimoschema* constructs a protective device that is a great step forward. When the adults are provided with biting mouth parts, as in the case of some of the true gall wasps, no provision is made by the larvæ at all, since the adults are able to shift for themselves.

PROBABLE CAUSE OF THE GALL

The following theories regarding gall formation by insects have been advanced: (1) That the gall results from mechanical irritation to the plant parts caused by the feeding of the insect; (2) that the gall results from the introduction of specific chemical substances by the insect; (3) that the gall structure results from stimulation induced by the by-products of body metabolism—urea and carbon dioxide—of the gall insect; (4) that the gall is produced as protective tissue for the purpose of isolating in a cell the

foreign body, the gall insect, and thus is a structure beneficial to the injured plant. With the insect under discussion, the first theory is the one held to be most probable.

VARIATION

The plants bearing galls were variable in size, some being only 5 or 6 inches tall whereas others were 5 feet or more in height with rare examples as tall as 6 feet. Between these extremes almost all possible heights were found.

The diameter of goldenrod stems varied with the luxuriance of the growth of the plants. Likewise, galls occurring on different parts of the stem, or on plants of different size, were found to vary in size with the varying thickness of the stems. The diameters of plant stems at points just below gall swellings ranged, in the 3,003 measured galls, from 2.3 to 10.8 mm., the average being 5.55 mm. (Table 1.)

Variations in the Galls

As a consequence of the range in size of plants and the various points of placement of galls upon the stems, galls were found at different heights above ground. Galls were usually found on the upper half of the goldenrod stalk, but this was influenced by the environment. They were frequently placed low on plants growing without much competition or without shading by other plants; but usually above the middle, or even terminal, on plants growing in competitive associations. Terminal galls examined in a lot of 1,000 amounted to 27.3 per cent. They were usually pear-shaped and ranged from 9 to 38 inches above the ground, the greater number being from 13 to 24 inches above the ground. The stem galls (72.7 per cent) were found from 6 to 36 inches above the ground with the greater number from 13 to 23 inches. They were usually spindle-shaped and placed below the crown of the plant.

Much variation in size and shape of galls was found. Of the 3,003 galls measured, no two were exactly alike. They varied in several respects, in the size of the gall, that is, in length, breadth, and interior capacity; in the position on the plant; and in the thickness and texture of the wall, some examples having pithy walls through which a pin could easily be inserted, whereas, on the other extreme, some were so woody that a pin could not be

TABLE 1. COMPARISON OF THICKNESS OF STEMS OF GOLDENROD PLANTS WITH THE SIZE OF GALLS THEY BORE AND THE SIZE OF SOME OF THE CONTAINED PUPÆ OF THE INSECT GALL MAKER

Diameter of stem just below gall	Number of examples	Average dimensions of gall (length by diameter)	Width of pupæ			
			Males		Females	
			Examples	Average width	Examples	Average width
Mm.		*Mm.*	*Number*	*Mm.*	*Number*	*Mm.*
2– 2.9	16	24.9 by 12.0	3	2.47	......	......
3– 3.9	286	28.3 by 13.3	58	2.69	44	2.97
4– 4.9	709	29.3 by 14.4	130	2.74	124	3.07
5– 5.9	909	30.4 by 15.2	191	2.77	179	3.09
6– 6.9	606	31.3 by 16.1	133	2.80	131	3.13
7– 7.9	308	33.3 by 16.9	77	2.82	62	3.15
8– 8.9	105	34.4 by 17.6	19	2.83	26	3.18
9– 9.9	55	35.2 by 18.1	10	2.82	10	3.21
10–10.9	9	36.8 by 19.8	1	......	2	3.27
Total	3,003	......	622	......	578	......

inserted at all. Some were linear, only a slight swelling of the stem indicating the presence of the gall insect. Others were globular, resembling the galls of the dipteron *Eurosta solidaginis* which occurred in association with *Gnorimoschema gallæsolidaginis,* but, incidentally, very rarely on the same plants. Most galls of *Gnorimoschema* were spindle-shaped, evidently typical of the species, whereas terminal galls were usually pear- or club-shaped. Extreme size and extreme shape—linear, spindle-shaped and globular—of the galls are illustrated in figure 3. Figure 4 shows a photograph of the various types.

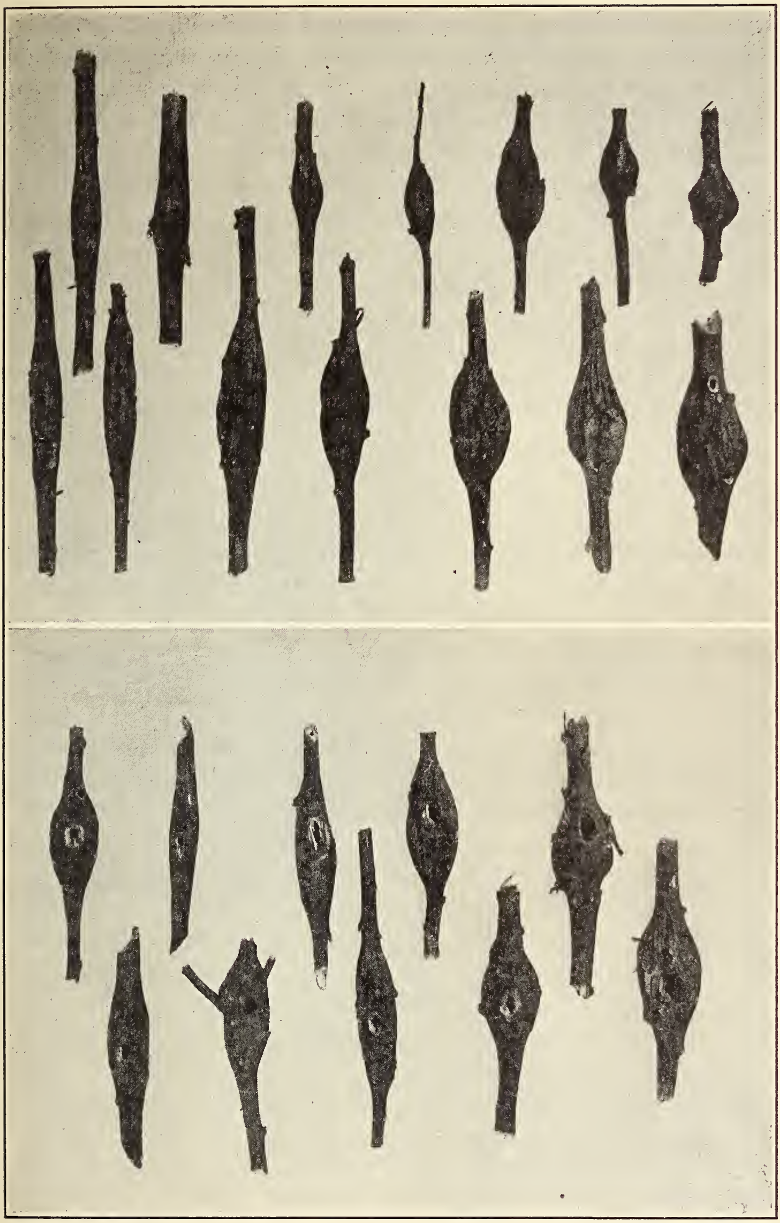
The galls ranged in length from 14 to 64 mm., and in thickness from 6 to 26 mm. The greater number, however, were between 24 and 35 mm. long and between 11 and 18 mm. in diameter.

Variations in the Insect Gall Makers

The variation in the size of the insect inhabitants of the galls could be conveniently ascertained by measuring the live pupæ. Of 1,200 measured pupæ, 622 males ranged in length from 7.9 to 12.0 mm. and in breadth from 2.05 to 3.30 mm., averaging 10.2 mm. long by 2.74 mm. broad. Similarly measured, 578 female pupæ ranged in length from 7.9 to 13.1 mm. and in breadth from 2.08 to 3.62 mm., averaging 11.4 mm. long by 3.11 mm. broad. One unique male pupa was found to be 5.6 mm. long by 1.5 mm. broad, much smaller than the smallest of the 622 male pupæ described above. In all of the above measurements the greater number of cases were grouped closely about the average.

Variations in the Emergence Plugs

The plugs that closed the emergence burrows varied somewhat in shape but most often were perfectly circular on both the inner and outer surfaces. They varied in diameter and in depth or thickness, and in the relationship of the two surfaces as to diameter. The inner surface was almost always of less diameter than the upper or outer surface; that is, the plugs were almost invariably "bungs" or stopper-shaped, and this difference between outer and inner diameters varied with the thickness of the plugs. The thickness of the plugs generally was dependent upon the thickness of the wall of the gall. In figure 5, extreme types of plug, as

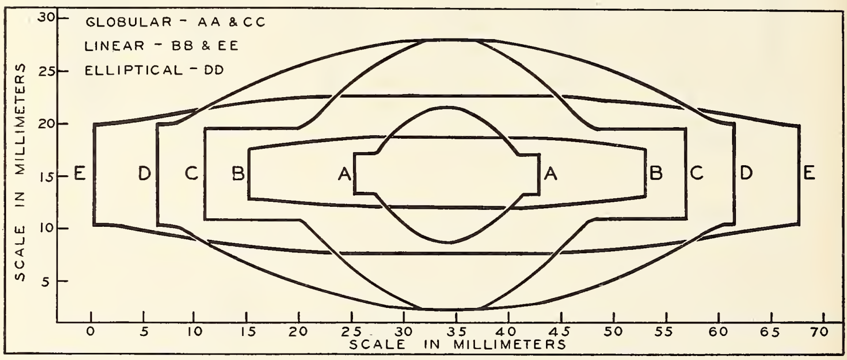


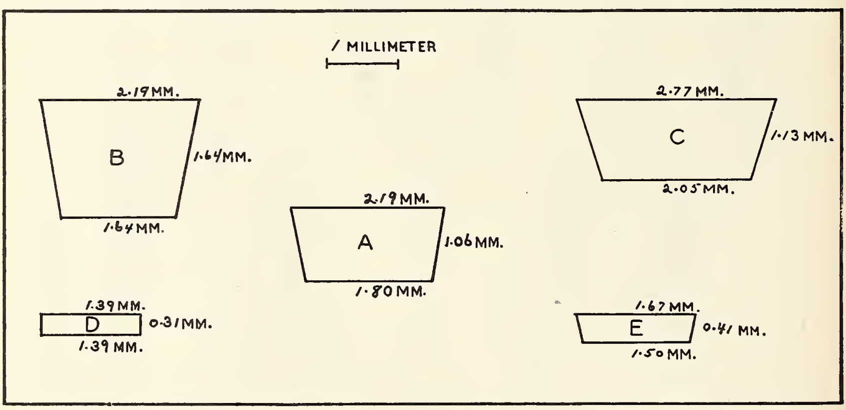
Above—FIGURE 4.—Various types of goldenrod galls. *Below*—FIGURE 6.—Goldenrod galls that have been attacked by birds.

well as an average plug, are illustrated. The outer diameter of 1,200 plugs ranged from 1.43 to 3.01 mm., by far the greater number being between 2 and 2.4 mm. Of 203 plugs that were completely studied, the upper surface ranged from 1.37 to 2.77 mm. (average 2.19) in diameter and the inner surface from 1.35 to 2.25 mm. (average 1.80). The thickness of the plugs ranged from 0.30 to 1.64 mm. (average 1.06). The difference between the outer and inner diameters of individual plugs ranged from 0.00 to 0.85 mm. (average 0.39).

DISCUSSION OF THE RELATIONSHIPS

It has been shown that the plants, the galls, and the insects inhabiting the galls all vary considerably in size, and it is the





Above—FIGURE 3.—Comparison of five extreme types of goldenrod galls. *Below*—FIGURE 5.—Types of plugs in goldenrod galls: A, average plug; B, extremely deep or thick plug; C, extremely wide plug; D, extremely small and unusual plug; E, thin plug of usual shape.

intention in the following paragraphs to show in what way the variation of the one is associated with the variation of the other.

Relationship of Diameter of Stem to Size of Gall

As previously noted, the diameter of the goldenrod stems immediately below the galls they bore ranged from 2.3 to 10.8 mm. Thus the largest stem observed was 4.7 times the diameter of the smallest. From field observations it seemed that small galls were usually found on small stems and large galls on large stems. This proved to be the case in 3,003 measured galls; in fact, it was found that the size of the galls increased in proportion to the stem diameter. A summary of the data is given in table 1. Plants were grouped into 9 size classes, according to stem diameter immediately below the galls, the size of the latter being averaged for each class. As shown in the table, the average gall size is larger proportionately as the stem diameter is greater, and the evidence indicates that, in general, a controlling factor in gall size is the diameter of the stem on which the gall is borne.

Relationship of Size of Pupa to Size of Gall

The range in breadth of pupæ was found to be from 2.05 to 3.31 mm. in males, and from 2.08 to 3.62 mm. in females, the pupæ occupying galls of various sizes. To determine whether the insects varied in proportion to the galls they inhabited, the former were arranged into 9 classes, according to breadth, the average size of galls inhabited by pupæ of each class being then determined. These data are given in table 2. In the case of each sex of the insect, it was found that the pupæ varied in breadth (here taken as a measure of size) proportionally to the size of the galls they inhabited, and it was indicated that a controlling factor in the size of the insect was the size of the gall which it inhabited or, very likely, the extent of the feeding area provided by the gall. Furthermore, female pupæ were on an average somewhat larger than male pupæ, as previously noted, and occupied on an average somewhat larger galls than the latter. Thus the average breadth of 578 female pupæ was 3.11 mm., while the average size of the galls they inhabited was 31.11 by 16.12 mm.; the average breadth of 622 male pupæ was 2.74 mm., and the average size of their galls was 28.87 by 15.23 mm.

TABLE 2. COMPARISON OF THE BREADTH OF PUPÆ OF THE INSECT GALL MAKER WITH SIZE OF THE GALLS THEY INHABITED AND THE DIAMETER OF THE EMERGENCE PLUGS OF THE GALLS

Breadth of pupæ in millimeters	Females				Males			
	Number of examples	Average size of galls		Average diameter of the plug	Number of examples	Average size of galls		Average diameter of the plug
		Length	Breadth			Length	Breadth	
		Mm.	Mm.	Mm.		Mm.	Mm.	Mm.
2.05–2.20	2	26.05	13.40	1.66	4	19.77	13.05	1.54
2.21–2.40	2	25.70	13.65	1.95	15	24.75	12.69	1.79
2.41–2.60	15	28.01	13.23	1.91	85	26.38	13.33	1.91
2.61–2.80	32	29.47	14.04	2.04	267	28.33	14.97	2.06
2.81–3.00	125	28.69	14.48	2.19	216	29.95	16.24	2.21
3.01–3.20	231	30.98	16.43	2.34	32	33.31	16.09	2.25
3.21–3.40	132	33.23	17.34	2.44	3	33.83	14.93	2.29
3.41–3.60	38	35.09	18.02	2.50	....	....	....	....
3.61–	1	40.30	18.80	2.84	....	....	....	....
Total	578	....	....	....	622	....	....	....
Average	....	31.11	16.12	2.31	....	28.87	15.23	2.09

Relationship of Size of Pupa to Diameter of Emergence Plug

To insure the free emergence of the moth from the gall it is necessary that an opening not only be prepared by the larva but that this opening be of suitable size, for if it is too small the moth will not be able to force itself through it. The size of the burrow and ''plug'' made by the insect are proportional to the size of the insect. This is shown in the data presented in table 2, and verified by placing 20 large pupæ in galls originally inhabited by small pupæ and sealing up the galls except for the emergence plugs, which were left undisturbed. Of these individuals, 1 pupa died, 18 gave rise to moths which died in the emergence burrow in their struggle for freedom, and 1 successfully emerged.

That suitable provision is made by the larvæ for moth emergence is shown by field examination of emerged galls, not a single example being found in which an adult had been unable to gain freedom by way of the emergence burrow. The relationship between the size of the burrow and the size of the insects may be a mere mechanical one, dependent upon the variation in the size of the larval mouthparts with larval size. At all events it was found that plug diameter varied directly with pupal size in each sex, and the size of the burrow was always such as to allow the escape of the adult moth. One unique male pupa was found to be only 1.5 mm. in breadth, and its emergence plug was 1.37 mm. in diameter.

Relationship of Diameter of Stem to Size of Pupa

Since the size of galls varies proportionately with the diameter of the stems of plants which bear them and the size of pupæ varies with the size of galls which they inhabit, it is obvious that the size of pupæ would vary proportionately with the diameter of the stems of plants bearing the galls they inhabit. This was found to be the case, as shown in table 1, in which the measurements of 1,200 pupæ are compared with data on gall size and plant-stem diameter.

PROTECTIVE VALUE OF THE GALL TO THE INSECT

While inhabiting the galls (that is, during the larval and pupal periods of the life cycle) more than half of the insects were de-

stroyed by one means or another. It is apparent, therefore, that while the gall provides possible protection from some destructive agencies, it is not particularly effective against enemies which, in one way or another, have learned to gain access to the galls in order to feed upon the contained gall maker.

FATE OF THE INSECT GALL MAKER

Of 3,500 galls studied in the fall of 1929 only 46.7 per cent gave rise to moths. The most important single destructive agency was birds. Nearly as important as these was the combined attack by 6 species of parasites. Birds and parasites combined destroyed 35.9 per cent of the fall-examined galls and 35.9 per cent of spring-examined galls. Relatively few larvæ or pupæ were found to perish because of disease. A few galls were taken by leaf-cutting bees and ants; and a considerable number were attacked by insect predators, particularly predacious coleopterous larvæ, which were able, apparently, to lift out the protecting plug and to gain entrance into the interior of the gall through the emergence burrow. The fate of the insects is given in percentages in table 4.

BIRDS AS ENEMIES

Birds penetrated the galls and devoured the insect inhabitants in 18.7 per cent of fall-examined galls and in 20.9 per cent of spring-examined galls. They gained access through the tip of the gall, about the emergence burrow, in 11.8 per cent of the cases; through the base of the gall in 1.5 per cent; and in 86.7 per cent of the examples they gained access through the side of the gall, as shown in figure 6. Birds usually made their attack when the larvæ were full grown or after they had pupated, since in 76.9 per cent of the examples the emergence plugs had been formed, which, as has been shown, is the last act of the larva before pupation. In most of the remaining 23.1 per cent of bird-attacked galls the emergence burrows had been partly excavated, indicating that the larvæ were approximately full grown. In the fall of 1929 it appeared that the feeding by birds was limited to a period of a few weeks only, in September or early in October, when the larvæ were full grown, or nearly full grown, or after pupation had occurred; but the species of bird concerned was not determined. In general,

only the largest galls were attacked by birds, perhaps because the larger stems that bore such galls afforded the firmer foothold needed by them in penetrating the galls.

Feeding by birds on this insect was general in the area studied, but not at all uniform in all localities, being found heavy in some spots, particularly in growths of large flourishing goldenrod plants, and very light in other spots. In other words, the heaviest bird feeding occurred in "pockets." In 35 collections of 100 galls each, the number penetrated by birds ranged from 1 to 48. In 9 collections, from 1 to 10 galls were attacked; in 17 collections, from 11 to 20; in 4 collections from 21 to 30; in 3 collections, from 31 to 40; and in 2 collections, between 41 and 48.

INSECT PARASITES AS ENEMIES

In the locality where these studies were made, six species of parasitic insects were found to attack *Gnorimoschema gallæsolidaginis,* usually in the larval stage. Three of these were important, and three were practically insignificant in importance; taken together, they accounted for but 17.26 per cent of 3,500 fall-examined galls. Each species of parasite is discussed briefly.

Copidosoma gelechiæ How.[2]

Copidosoma gelechiæ proved to be the most important insect parasite. The adult parasite oviposits in the host egg in the fall, according to Leiby.[3] In 94.9 per cent of galls containing larvæ parasitized by this species the emergence plugs had not been formed. This parasite develops polyembryonically, and a large number of parasites pack the body of the host larva, which is usually found to be swollen to several times its normal size when the parasites have pupated within its body. The parasite is usually found in the larger galls.

Of 100 larvæ from which adult parasites of *C. gelechiæ* emerged, 63 gave forth female parasites and 37 gave forth male parasites, the adult parasites from any one host larva being almost always of the same sex. Leiby[3] found that unfertilized eggs of this

[2] Determined by A. B. Gahan.

[3] Leiby, R. W., The polyembryonic development of *Copidosoma gelechiæ,* with notes on its biology. Jour. Morphology 37: 195–285. 1922.

parasite gave forth male adults and that fertilized eggs gave forth either male or female adults. In three instances noted by the writer a few males issued from larvæ giving forth large numbers of adult female parasites. In these cases more than one egg may have been laid by the adult parasite, or an egg by each of two adults may have been laid in such host eggs. Patterson[4] found similar cases which he attributed to this cause.

From the 100 parasitized host larvæ mentioned above, a total of 19,009 adult parasites emerged during the fall of 1929. Of these 13,427, or 70.63 per cent, were females; and 5,582, or 29.37 per cent, were males. The number of parasites emerging from a single larva varied greatly. In the case of female parasites the range in population per host was from 27 to 412; in the case of male parasites from 41 to 259 issued from host larvæ. Patterson,[4] in studying this parasite on *Gnorimoschema salinaris* Busck, found that the number of parasites per host in female broods, in 90 instances, ranged from 25 to 395, with an average of 198.48 individuals per host; and in male broods, in 62 instances, the range was from 41 to 345, the average being 175.32 individuals per host. Since, in the writer's investigations, the host larva that contained 27 parasitic pupæ appeared to be of approximately normal size, even including the parasites, or a little larger, the increase in larval bulk in the most heavily parasitized host larva—that containing 412 parasitic pupæ—appeared to be 15 times that of a normal larva. Of the female broods, in approximately half the cases, the parasitic population ranged from 100 to 250 per host, and nearly half of the male broods numbered from 100 to 200 per host.

The average number of female parasites per host larva was 213.1; the average number of male parasites per host larva was 150.9.

It was found that parasitized larvæ varied greatly in size and that this variability in size roughly paralleled a variability in gall size, a condition previously noticed in the pupæ of the gall insect and the galls in which they were found.

Although the populations of parasites per host larva were ex-

[4] Patterson, J. T., Observations on the Development of *Copidosoma gelechiæ*. Biol. Bul. 29: 333–372, illus. 1915.

tremely variable, no indication was found that competition for food among the parasites had at any time been keen. This is illustrated in the remarkable uniformity in size found in the adult parasites.

In order to determine variability in size of these parasites, the fore-wings of 10 specimens from each of the 100 host larvæ were measured. The average wing size of parasites emerging from individual host larvæ ranged from 1.33 to 1.72 mm. in the case of males, and from 1.31 to 1.62 mm. in the case of females. But it was when parasite size was studied in connection with parasite population groups that uniformity in parasite size was most noticeable. This is shown in table 3.

TABLE 3. MEAN SIZE OF FOREWING OF ADULT COPIDOSOMA GELECHIÆ FROM LARVÆ OF GNORIMOSCHEMA GALLÆSOLIDAGINIS HAVING THE VARIOUS PARASITE POPULATIONS INDICATED

Number of parasites per larva	Mean length of forewing of adult parasite	
	Females	Males
	Mm.	*Mm.*
1– 50	1.45	1.72
51–100	1.44	1.59
101–150	1.44	1.58
151–200	1.44	1.54
201–250	1.46	1.57
251–300	1.42	1.64
301–350	1.43	....
351–400	1.47	....
401–450	1.48	....

Adult male parasites were somewhat larger, on an average, than females, the average length of the fore-wing of 370 males being 1.56 mm., with three-fourths of the total falling between 1.51 and 1.71 mm. Of 630 females the average wing length was 1.43, with more than half falling between 1.37 and 1.51 mm. The populations of females in host larvæ were relatively larger than of males.

Calliephialtes notanda (Cress.)[5]

The second most important parasite, attacking 4.83 per cent of 3,500 fall-examined galls, was *Calliephialtes notanda*. Galls of all

[5] Determined by R. A. Cushman.

sizes were attacked by this parasite, but on the whole these galls were smaller than those attacked by *Copidosoma.* The adults of *Calliephialtes* emerged, with one exception, during the autumn. The female is provided with a long ovipositor, which she apparently is capable of inserting through the wall of the gall in order to reach the contained host insect. In 74 per cent of the observed instances, the host larva was able to complete the emergence burrow and plug before perishing. In the remaining 26 per cent of observed instances, the emergence plug had not been formed. When the larva of the parasite becomes full grown it forms a rather long, flat, brown-colored, leathery cocoon, which, in the cases observed, was peculiar in that it usually lay with the head of the parasite toward or even adjacent to the emergence burrow formed by the host larva for the escape of the moth; and it was by the burrow that the adult parasite usually escaped, although it is capable of gnawing its way through the wall of the gall when necessary. This species usually occurred singly, although in one instance two parasites were present. Although usually a primary parasite, it is sometimes a secondary, for in three instances adults emerged from cocoons of *Microgaster,* and one adult emerged from a host larva filled with pupæ of *Copidosoma.* It is able, apparently, to accommodate itself to whatever food may be available in the galls.

The adults of the parasite are extremely variable in size in each sex, although the males are usually smaller than the females. Size was judged in this case by measuring the length of the cocoon, for the reason that many parasites had issued before collections of material were made. The largest cocoon observed was 17.1 mm. long; the smallest, 6.8 mm. long. As was found to be the case with pupæ of the host insect, the variation of the parasite cocoons was comparable to variation in size of the galls in which they were found.

Microgaster gelechiæ Riley[6]

Microgaster gelechiæ was the third in importance as a parasitic enemy of the gall insect, attacking 4.40 per cent of 3,500 fall-examined galls. It was always found singly. The host larva gnaws the usual emergence burrow but rarely cuts an opening to

[6] Determined by A. B. Gahan.

the outside, leaving intact a portion of the wall of about the thickness of what would be the plug. When full grown the parasitic larva leaves the host larva and spins a cocoon of white silk, more or less fluffy in appearance; and in this, within the protecting gall, it passes the winter, emerging the succeeding spring. This parasite is more uniform in size than the preceding species, although varying somewhat, 60 per cent of the cocoons being from 6.7 to 6.9 mm. in length, the full range being from 6 to 7.3 mm.

Eurytoma bolteri Riley[7]

The fourth parasite in importance, attacking 1.29 per cent of 3,500 fall-examined galls, was *Eurytoma bolteri.* The parasitic larva feeds externally upon the larva or pupa of the gall insect, or upon other parasites. It was often found in galls parasitized by *Copidosoma,* in which case it devoured numbers of the pupæ of this parasite in the host larva, causing irregular devoured areas to appear in the inflated and rigid parasitized larva of the gall insect. This species occurred almost always singly per gall, and pupated without forming a cocoon. It was quite variable in size. Usually the adult parasites emerged in the fall, but a few remained in the galls over winter, emerging the following spring. It was usually found inhabiting smaller galls.

Tetrastichus sp.[8]

A small parasite, *Tetrastichus* sp., was found in only 18 out of 3,500 fall-examined galls, destroying 0.51 per cent of the gall insects. It attacks the pupæ exclusively, and the number of adult parasites emerging from a single pupa of the host ranged from 3 to 42. In certain instances adult parasites emerged in the autumn; in others, they passed the winter within the host pupæ, emergence of the parasites taking place the following spring. This species of parasite employs a unique method of gaining entrance into the galls. It gnaws its way in, but always through the emergence plug, thus choosing the one spot in the wall of the gall which is thinnest. Galls attacked by this parasite could easily be recognized by the small round entrance burrow of the parasite, usually at or near the center of the plug, but sometimes at its edge.

[7] Determined by A. B. Gahan.

[8] Determined by A. B. Gahan.

Microbracon furtivus (Fyles)[9]

The least important of the parasites, *Microbracon furtivus,* was represented in but 8 of 3,500 galls examined in the fall of 1929, thus being responsible for the death of 0.23 per cent of the gall insects. The number of parasites attacking individual gall insects was very variable, and their size varied according to population. From 3 to 22 of these parasites were found in individual galls, the average number of cocoons per gall being 8.1. This parasite attacks the larva of its host, and, when through feeding, the parasitic larvæ spin individual brown cocoons which are grouped about the inner wall of the gall at the base, just above the pile of excrement deposited by the gall insect. The cocoons adhere closely to the wall of the gall, and are inconspicuous, colored much like the wall and easily overlooked. The length of cocoons ranged from 2.6 to 6.1 mm., while the average length of cocoons in the various parasite populations per gall was as follows: With 3 cocoons per gall the average length was 5.6 mm.; 4 cocoons per gall, 4.78 mm.; 5 cocoons per gall, 4.92 mm.; 6 cocoons per gall, 4.45 mm.; while with 22 cocoons per gall they averaged 3.2 mm. in length. Females of this parasite have an ovipositor of sufficient length to be inserted through galls having medium thick walls. The insects pass the winter in the cocoons in the galls, the adult parasites emerging in the spring.

DISCUSSION OF PARASITISM

In the 35 collections of 100 galls each, made in the fall of 1929, each species of parasite (and parasitization as a whole) was quite differently represented. The extreme variation in occurrence of the several species and the parasitization in general, and also other causes of death, are given in table 4. Parasites, both in general and specifically, occurred more numerously in "pockets" in the field, a condition heretofore observed in the case of bird feeding. Four species of parasites were clearly larval parasites, although one, when pressed for food, fed on competing parasites; one was strictly a pupal parasite; while one was an indiscriminate feeder, being able to subsist on larvæ or pupæ of the gall insect, or on other parasites. On the whole, of 604 parasitized galls examined, relatively few showed competition among these parasites.

[9] Determined by A. B. Gahan.

TABLE 4. FATE OF INSECT GALL MAKER AT RICHMOND, VA., 1929–30

	Moths issued	Taken by birds	Destroyed by insect parasites							Larvae died of disease	Pupae died	Galls taken by bees or ants	Destroyed by insect predators, or fate unknown
			Total parasitism	*Copidosoma gelechiæ*	*Calliephialtes notanda*	*Microgaster gelechiæ*	*Eurytoma bolteri*	*Tetrastichus* sp.	*Microbracon furtivus*				
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Fall of 1929 examinations, 3,500 galls	46.75	18.69	17.26	6.00	4.83	4.40	1.29	0.51	0.23	3.38	0.80	0.63	12.49
Spring of 1930 examinations, 234 galls	42.74	20.94	14.96	2.57	6.41	2.99	0.85	....	2.14	3.42	2.13	....	15.81
Greatest percentage in any one collection of 100 galls	76.00	48.00	28.00	13.00	16.00	11.00	6.00	....	2.00	9.00	8.00	2.00	23.00
Least percentage in any one collection of 100 galls	19.00	1.00	7.00	1.00	0.00	0.00	0.00	....	0.00	0.00	0.00	0.00	1.00

Of the two larval parasites which occurred several to a gall, and populations of which differed greatly in different galls, one was shown to suffer little variation in the size of adult parasites, as between small and large populations, while the second showed considerable variation in the size of individuals when present in various numbers.

The sizes of the galls in which the several parasites were found were, on the average, somewhat different. Except for *Copidosoma,* which occupied large galls, the parasites were found in galls smaller, on an average, than the general average of gall size. The average sizes of the galls, the insect inhabitants of which met various fates, is given in table 5, in which this matter is made clear.

TABLE 5. COMPARISON OF THE SIZE OF GALLS, THE INSECT MAKERS OF WHICH MET VARIOUS FATES*

Description of fate of the insect gall maker	Number of examples	Average size of galls	
		Length	Breadth
		Mm.	*Mm.*
Galls containing pupae	1,200	29.95	15.67
Galls containing female pupae	578	31.11	16.12
Galls containing male pupae	622	28.87	15.23
Galls attacked by birds and parasites	1,084	31.97	15.17
Galls attacked by birds	592	33.96	15.98
Galls attacked by parasites	492	29.62	14.19
Copidosoma gelechiæ	121	34.09	15.72
Calliephialtes notanda	169	28.53	13.81
Microgaster gelechiæ	152	28.02	13.73
Eurytoma bolteri	43	26.55	13.15
Microbracon furtivus	7	32.19	13.41
Galls attacked by predators, or fate unknown, etc.	719	30.02	15.21
General average of all galls	3,003	30.69	15.37

* Some 500 galls were examined for fate and discarded before measurements were undertaken.

When the larva of the gall insect becomes full grown it lays down a sheet of silk on the inner wall of the gall. The effect is to waterproof the gall, a condition to which the various parasites appear to be adapted. Parasites kept indoors in glass vials stoppered with cotton hibernated under quite dry conditions; yet they passed the hibernating period perfectly, as did certain guests of the gall insect, notably leaf-cutting bees. Moisture during hiber-

nation was certainly not necessary in these cases, nor for that matter was it necessary for the pupæ of the host insect or fall-emerging parasites, which were kept under similar conditions for shorter periods.

INSECT PREDATORS

A number of the gall insects were destroyed by miscellaneous enemies and these have been grouped with those whose fate was unknown. Predacious larvæ of Carabidæ and Lampyridæ were found in certain galls, and they probably had devoured the gall-making insect. These larvæ, having strong mandibles, were apparently able to pry out the emergence plug and so gain entrance to the galls, and they were found only in galls in which the emergence plugs had been formed.

Two species of ants were occasionally found in galls. They had devoured the pupa of the gall insect or its parasites, and very likely were also able to pry off the emergence plug, being found only in galls in which this structure had been formed. A number of mites were often found running over the pupa of the gall insect, but these may not have been enemies.

INSECT GUESTS

The insect guests of the gall maker were of two kinds, those that used the galls while they were still occupied by the gall-making insect and those that used the deserted galls. Among the former may be mentioned leaf-cutting bees, that excavated an opening into the gall, in which they constructed one or more of their leaf-covered brood cells. Goldenrod stalk borers (larvæ of Coleoptera) that, in gnawing through the stalk, enter the galls and feed therein were frequently seen. The empty galls, from which moths had emerged or that had been attacked by birds or parasites, served as snug retreats for hosts of small spiders during the winter. From these deserted galls were also collected species of small Hemiptera and Coleoptera representing several families, as well as hibernating thrips and ants.

SUMMARY

In the foregoing paper the writer discusses the probable cause of the gall formation produced in goldenrod by *Gnorimoschema*

gallæsolidaginis, the habits of the insect gall maker, the variation found in plants, galls, and insects (both host and parasites), the causes of this variation, and the efficiency of the gall in affording protection for the insect occupants from natural enemies.

The study was carried on at Richmond, Va., in 1929, and consisted of examinations of 3,500 galls.

From measurements it was found that the size of the insect gall maker varied with the size of the galls. The size of the latter varied with the luxuriance of growth of the goldenrod plants, and growth of plants varied in turn with numerous ecological factors, such as type and fertility of soil, exposure of plants to light, and competition of goldenrod plants with others of the same or other species. Ultimately it appeared that the size which the insect gall makers attained depended in general upon the conditions under which the infested plants grew.

Descriptions are given of the remarkable means which the larva of the gall insect provides for the escape, and at the same time the protection, of the moth. This is the making of a ''stopper'' or ''bung'' to the previously and otherwise completely walled gall, which is the last act of the larva of the gall insect before pupating. This stopper is so constructed that, while the merest pressure from within will force it out and open the passage through which the moth can escape, it can hardly be forced in by pressure directed on it from the exterior.

Birds, probably woodpeckers, proved to be the most important enemy of the gall insect, taking the insects from 18.69 per cent of the galls examined in the fall of 1929. Parasites were collectively only slightly less important as enemies, being responsible for the death of 17.26 per cent of the host insects at the same time. The insect parasites noted were of 6 species, the most numerous species destroying 6 per cent and the least numerous species taking 0.23 per cent of the insect gall makers. In the cases of some of these parasites, it is shown that the individuals varied in size with the size of the galls they inhabited, and consequently with the size of the host larvæ, which provided them with a greater or a lesser amount of food.

REVISION OF THE ROBBERFLY GENUS TARACTICUS LOEW WITH DESCRIPTIONS OF THREE NEW SPECIES (DIPTERA; ASILIDÆ)

By A. Earl Pritchard
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The genus *Taracticus* was erected by Loew (1872) for *Dioctria octopunctata* Say, a common species in the eastern United States. Williston has described three species from southern Mexico and transferred *Ceraturgus vitripennis* Bellardi, also from Mexico, to this genus. Curran has described an additional species from Arizona. As a result of the author's collecting in Mexico in 1935 and in the West in 1936, two new species from Mexico and one new species from California were taken which are described in this paper.

I am indebted to Dr. C. H. Curran for the loan of cotypes of *similis* Will. and *nigripes* Will. for study and redescription.

Taracticus Loew

1872. *Taracticus* Loew, Berl. Ent. Zeitschr., xvi: 64.
1904. *Dioctrodes* Coquellett, Proc. Ent. Soc. Wash., vi: 181.

Key to Species

1. Abdominal pollinose markings restricted to first four abdominal segments ... 2
   Abdominal pollinose markings on at least five abdominal segments ... 3
2. Femora reddish-yellow; female subgenital plate emarginate on distal third (Guerrero, Mexico) ... *aciculatus* n. sp.
   Femora nearly entirely black; over half of female subgenital plate divided (Guerrero, Mexico) ... *vitripennis* (Bellardi)
3. Mystax in large part black (Guerrero, Mexico) ... *nigrimystaceus* Williston
   Mystax white ... 4
4. Mesonotum wholly pollinose (Arizona) ... *ruficaudus* Curran
   Mesonotum with bare, black vittae ... 5
5. Legs mostly black; median mesonotal vittae strongly widened near anterior end; mesonotum clothed with small, spine-like bristles ... 6
   Legs mostly light yellowish-red; median mesonotal vittae without such widening; mesonotum clothed with hairs ... 7
6. Abdominal markings approximated or connected dorsally; dorsal spine of third antennal segment occurring at two-thirds the length of that segment (Guerrero, Mexico) ... *guerrerensis* n. sp.

Abdominal markings rather widely separated dorsally; dorsal spine of third antennal segment at three-fourths the length of that segment (Guerrero, Mexico) .... *nigripes* Williston

7\. Disc of scutellum with a pollinose median stripe; with a pair of marginal scutellars 8

Disc of scutellum bare; without marginal bristles (Guerrero, Mexico). *similis* Williston

8\. Third antennal segment over three times as long as first two combined, the dorsal spine just before the middle of that segment (California). *paulus* n. sp.

Third antennal segment two and one-half times as long as first two combined, the dorsal spine a little beyond the middle of the segment (Eastern U. S.) .... *octopunctatus* (Say)

Taracticus aciculatus new species

Black; legs largely yellowish, the tarsi annulate; vestiture entirely pale, the mesonotal hairs prominent; caudo-lateral, rectangular pollinose spots on abdominal tergites one to four. Length, 7 to 10 mm.

MALE.—Cinereous pollen on front and thinly on rear of head except at orbits, the occiput bare, shining black; pale ochreous pollen on the face; mystax white, confined to a thin row of oral bristles and a few hairs above; occipito-orbital bristles small, white; ocellar tubercle with a pair of white bristles; antennæ black; first antennal segment two and one-half times as long as broad, above bare and coriaceous with several distal, pale microchætæ, below bearing white bristles that attain the length of the segment; second two-thirds as long as the first, brown pollinose, with a few pale microchaetæ at tip above, and a white bristle below nearly as long as the proximal two segments combined; third three times as long as proximal two segments combined with the dorsal spine placed just before the middle, and with the distal half densely black pubescent giving the segment an appearance of slight enlargement.

Pronotum cinereous pollinose, bare above; collar with a row of yellowish bristles; mesonotum mostly bare of pollen and strongly, transversely coriaceous, clothed except on the median geminate vitta with strong, bristle-like, pale yellow hairs and with white bristles laterad, posteriorly, and bordering and bisecting the median vitta; median vitta parallel sided, pollinose anteriorly and bearing bristles posteriorly; each lateral stripe wide, covering the mesonotum posteriorly and falling short of the anterior calli; the coarse, ochreous, mesonotal pollen present as an anterior square on each side of the median stripe connected across the anterior end of median stripe and extending down the middle and along each side of the stripe to a variable, small extent; scutellum transversely rugose, marginally gray pollinose and with a few small, white hairs on the disc; pleuræ and metanotum cinereous pollinose, the former yellowish above.

Legs nearly bare, the bristles and hairs all white; tarsi and tips of tibiæ with moderately dense, appressed, silvery hairs; coxæ pollinose similar to

thoracic pleura; trochanters black, shining; femora reddish-yellow proximad, black on distal two-thirds of anterior pair, on distal fifth of middle pair, and on distal one-third to one-half of hind pair; tarsi black with the proximal part of the segments narrowly yellow on the anterior four pairs, broadly on the posterior pair.

Wings dark gray with a luteous tinge on proximal half; anal cell narrowly open or closed in the margin; fourth posterior cell rather strongly narrowed distal.

Abdominal tergum shining black, coarsely punctate except on caudal margins of the segments; clothed with minute hairs, yellowish dorsad, white and longer on lateral margins; segment on cincereous pollinose laterad and with lateral white bristles; two, three, and four each with a caudo-lateral, gray pollinose rectangle about twice as wide as long; genitalia white haired.

FEMALE.—Similar.

Holotype.—Male, Chilpancingo, Guerrero, Mexico, June 28, 1935 (A. E. Pritchard), in collection of the University of Minnesota.

Allotype.—Female, Chilpancingo, Guerrero, Mexico, June 28, 1935 (A. E. Pritchard), in collection of the University of Minnesota.

Paratypes.—Eight males, one female, Chilpancingo, Guerrero, Mexico (A. E. Pritchard).

This species is related to *vitripennis* which it resembles very closely, differing only in having the legs reddish-yellow instead of black with a little yellow, and in having the female subgenital plate broadly notched mesad on the distal third in contrast to a division of over half the plate in the other species. *T. aciculatus* was taken with *vitripennis* and *guerrensis* on the leaves of the shrubbery over the mountains near Chilpancingo.

Taracticus vitripennis (Bellardi)

1861. *Ceraturgus vitripennis* Bellardi, Sagio di Ditterol. Messic., ii: 60.

1901. *Taracticus vitripennis* Williston, Biolog. Centrali-Americana, Dipt., i: 313.

Black; legs largely black, the posterior tarsi distinctly annulate; mesonotum with strong hairs; abdomen with caudo-lateral, pollinose rectangles on segments two to four. Length, 8 to 10 mm.

MALE.—Head cinereous pollinose, rear of head thinly so, the occiput bare and shining black; face, however, ochreous pollinose;

mystax a row of oral bristles with hairs above on either side; fine occipito-orbitals, two ocellars, mystax, palpal hairs, and thin beard all white; first segment of antenna two and one-half times as long as broad, shining black, above coriaceous, thinly brown pollinose with pale microchaetae on distal half, below with white bristles the length of the segment; second two-thirds as long as first, brown pollinose, with pale microchaetæ above at tip, the ventral bristle white, a little longer than the first segment; third three times as long as first two combined, brown pollinose, densely black pubescent on distal half, the dorsal spine placed at the middle of the segment.

Pronotum shining black; propleurae pale ochreous pollinose and white haired; collar with a row of pale yellow bristles; mesonotum mostly shining black, transversely coriaceous; the coarse, ochreous pollen extending in a thin line between the median dorsal vittae, and as two rectangles between the anterior calli and middorsal vittae; the two rectangles connected across the anterior end of these vittae and briefly extending posteriorly as a line between the middorsal and lateral vittae; covered with strong yellowish hairs and, posteriorly, white bristles, leaving only the parallel sided median vittae bare; scutellum with a few white hairs, shining black, roughly, transversely rugose, the posterior margin and metanotum densely cinerous pollinose; pleurae and coxae cinereous pollinose.

Legs shining black except narrow proximal part of hind femora, tips of all femora, proximal fourth of anterior four tibiæ, proximal third of posterior tibiæ, and proximal parts of tarsal segments yellowish; bristles and hairs all white, the tarsi and ends of tibiæ with appressed, silvery hairs.

Wings gray, tinged with flavescence on proximal half; fourth posterior cell rather strongly narrowed distad.

Abdomen shining black, coarsely punctate, golden setulose; sides of segment one thinly white pilose and cinereous pollinose, the pollen dense and white behind the short row of predistal, pale yellowish bristles; two, three, and four each with a caudo-lateral, rectangular, densely white pollinose spot about two and one-half times as wide as long; lateral margins with rather thick, short, white hairs; genitalia black, white haired.

FEMALE.—Similar, the tarsi less annulate; ovipositor reddish or reddish-brown.

Records.—Chilpancingo, Guerrero, Mexico, June 28, 1935 (A. E. Pritchard), four males and four females. Described from Mexico by Bellardi as a *Ceraturgus*. Williston, with specimens from Chilpancingo, has correctly transferred the species to this genus on a basis of the description. The incrassate appearance of the antennæ is not unique with this species.

In *guerrerensis* and *nigripes,* the thoracic vestiture consists of short spines; in *aciculatus* and *vitripennis,* of long bristles; in *octopunctatus, paulus, similis, nigrimystaceus,* and *ruficaudus,* of fine hairs. The dorsal spine of the third antennal segment is before the middle of that segment in *vitripennis, aciculatus,* and *paulus,* beyond the middle in the other species.

Taracticus nigrimystaceus Williston

1901. *Taracticus nigrimystaceus* Williston, Biolog. Centrali-Americana, Dipt. i: 313.

Black; mystax largely black; legs black except narrowly at knees; mesonotum with long, slender hairs; abdomen with caudolateral, rectangular pollinose spots on all the segments. Length, 10 to 13 mm.

"Black. Antennæ black; third joint nearly three times the length of the first two together, with a small bristle on the upper margin near the distal third. Face and front covered with yellowish-white tomentum or dust; face distinctly convex on the lower part, projecting in profile, and clothed with long black hairs to near the middle, somewhat intermixed with white ones on the sides. Occiput white-dusted on the sides and clothed with white hair. Mesonotum covered with light brownish-yellow dust, leaving two median, narrowly separated, stripes and two rounded subcontiguous spots on each side dark brown; there are two bristles near the outer end of the suture and one on each post-alar callus; otherwise, the mesonotum is clothed with very sparse, long, slender hairs. Abdomen elongate, with the sides nearly parallel, the median segments not twice as long as broad; shining metallic black, punctulate, covered with short, sparse, black hairs, except on the smooth, narrow, hind margin of the segments; all the seg-

ments with a small, transverse, yellowish-white, opaque spot on each lateral hind margin. Legs black, the knees very narrowly reddish; bristles and the short pile of the inner side of the tibiæ and tarsi yellow; underside of the hind femora with the usual bristles. Wings tinged with yellowish, slightly infuscated distally.''

Known only from type male and female, Xucucmanatlan, Guerrero, Mexico.

Taracticus guerrerensis new species

Black; legs largely black; mesonotum with small spine-like bristles; caudolateral, pollinose stripes on segments two to six, approximated dorsally. Length, 9 to 11 mm.

MALE.—Head cinereous pollinose, on the face dense and shining, nearly white; ocellar tubercle and vertex on either side of it bare, shining black; mystax white, confined to oral bristles and a few hairs above them on each side; occipito-orbital bristles small, white; two ocellar bristles, thin beard, and palpal hairs all white; antennæ black, brown pollinose; first segment two and one-fourth times as long as broad, with microchaetæ above on distal half, the longer bristles on the ventral side rarely over one-half as long as the segment; second three-fourths as long as first, with microchaetæ at tip above, the ventral bristle not over the length of the first segment; third three times as long as first two combined, densely pubescent beyond the dorsal spine placed at two-thirds the length of the segment, the distal third not tapering and a little wider than proximal portion.

Prothorax with notum shining black, the collar with nearly white bristles; pleuræ cinereous pollinose, the anterior lobe with long white hairs; mesonotum mostly barren of pollen, strongly transverse coriaceous, clothed, except on front half of median vittae, with small, strong, spine-like bristles, the posterior half of the lateral margin with the bristles long and strong; median stripe wide, bisected by a line of pollen, and with a strong projection on either side at the level of the anterior calli which is nearly as wide as the stripe itself, abrupt in front and tapering behind; lateral stripes wide, covering most of the remainder of the thorax, constricted behind the anterior calli, but continued laterad over most of each callus; the pale pollen of the right side thus appearing as a question mark curving around the lateral projection of the mesonotal stripe—that of the left side reversed; scutellum with caudal margin ochreous pollinose and with a pair of very short, yellowish bristles, the disc without pollen, transversely rugose and with several short, white hairs on either side; mesopleuræ cinereous pollinose, ochreous tinged above; metanotum cinereous pollinose.

Legs black with knees yellowish, femora below often reddish, tibiæ sometimes reddish, and hind metatarsi reddish proximal; vestiture sparse; bristles white, appressed hairs white, below on hind tarsi yellowish.

Wings light gray, the proximal half luteous tinged anteriorly and hyaline posteriorly.

Abdomen black, nearly bare, punctate, each puncture with a yellowish setula: white hairs on lateral margin moderately thick, the predistal bristles on sides of first four segments extending to the caudal margin of the segments; two or six each with a cinereous to ochreous, caudo-lateral stripe on the sides of each segment separated dorsad by about the width of the stripe, or a little more so on anterior and sixth segments; genitalia white haired.

FEMALE.—Similar, the face and front ochreous pollinose; the abdominal markings more extensive, being usually connected on four and five to form a pollinose caudal margin for these segments.

Holotype.—Male, Chilpancingo, Guerrero, Mexico, June 28, 1935 (A E. Pritchard), in the collection of the University of Minnesota.

Allotype.—Female, Chilpancingo, Guerrero, Mexico, June 28, 1935 (A. E. Pritchard), in the collection of the University of Minnesota.

Paratypes.—Ten males, four females, Chilpancingo, Guerrero, Mexico, June 28, 1935 (A. E. Pritchard).

T. guerrerensis is related to *nigripes,* readily separated by having the abdominal markings approximated or connected dorsally, and by having the dorsal spine of the third antennal segment before the middle of that segment.

Taracticus nigripes Williston

1901. *Taracticus nigripes* Williston, Biolog. Centrali-Americana, Dipt. i: 313.

Black; legs black except narrowly at knees; mesonotum with small, spine-like bristles; caudo-lateral, pollinose triangles on abdominal segments two to six. Length, 8 to 11 mm.

Face and front white to ochreous pollinose; rear of head cinereous pollinose, the upper orbits dark brown pollinose; ocellar tubercle bare, shining black; occipito-orbitals and ocellars brownish yellow; antennal bristles brown; mystax light yellowish with several mixed rows of bristles in the middle and white hairs and a bristle above on either side; first antennal segment a little less than twice as long as wide, bare, with brown microchaetae above and numerous bristles below about as long as first two segments combined; second three-fourths as long as first, the long bristles below about as long as proximal two segments together, tapering beyond the dorsal spine placed at three-fourths the length of the segment.

Prothorax ochreous pollinose, the posterior notal lobe bare in the middle; collar with rather long bristles; mesonotum ochreous pollinose, the bisected mid-dorsal and wide lateral stripes bare, transversely striate; covered with small spine-like bristles except on the vittæ, and with several lateral bristles; disc of scutellum bare, posterior margin and metanotum ochreous pollinose; pleuræ ochreous pollinose above, cinereous below.

Legs black, the knees narrowly yellowish; vestiture yellowish, the bristles paler.

Wings nearly hyaline, very lightly washed distad and with yellow proximad; fourth posterior cell very little narrowed.

Abdomen finely punctate with golden setæ; first segment cinereous pollinose laterally; second to sixth with caudo-lateral, cinereous triangles tapering inward with a base about twice as wide as the altitude; white hairs on lateral margin sparse; predistal bristles on sides of only first two segments reaching the posterior margin of the segment; genitalia white haired.

Known only from the type material, Xucumanatlan, Omiltene, and Chilpancingo, Guerrero, Mexico. The specimens Dr. Williston mention from Chilpancingo as having the wings quite dark anteriorly are probably the species described as *guerrerensis*.

Taracticus ruficaudus Curran

1930. *Taracticus ruficaudus* Curran, Amer. Mus. Nov., 425: 4.

Black; legs and caudal two abdominal segments reddish; caudolateral, pollinose triangles on abdominal segments two to six. Length, 11.5 mm.

"Female.—Face and lower half of occiput pale yellow, the front and upper half of the occiput brownish-yellow pollinose. Hairs and bristles pale yellowish or whitish. Antennæ black, the apical two segments reddish-brown pollinose; third segment very long, the spine situated a little beyond the apical third of the upper surface.

"Thorax brownish-ochreous pollinose, the pleura somewhat paler; pile and bristles yellowish. Mesonotum with a pair of narrow, very obscure darker vittæ and a spot on either side posteriorly. Scutellum shining brown, its border gray pollinose, its disc strongly roughened.

''Legs reddish; coxæ black, grayish-white pollinose and pilose; apices of tarsal segments brownish. Hair and bristles yellowish.

''Wings luteous on more than the basal half except posteriorly, grayish apically. Squamæ and halteres reddish yellow.

Abdomen shining black, with moderately fine punctures; hair very short and yellowish, on the sides and venter longer and whitish. Second to sixth segment with a transversely triangular yellowish-white, pollinose spot, the sides of the first segment broadly covered with similar pollen. Apical third of the sixth and the whole of the following segments reddish. Venter gray pollinose.

''Holotype.—Female, Mud Springs, Santa Catalina Mts., Arizona, July 17–20, 1916 (F. E. Lutz).''

Taracticus similis Williston

1901. *Taracticus similis* Williston, Biolog. Centrali-Americana, Dipt. i: 312.

Black; legs largely red; mesonotum with inconspicuous hairs; caudo-lateral, pollinose triangles on abdominal segments two to five. Length, 10 to 12 mm.

Face ochreous pollinose, the front grayish, yellow tinged; rear of head cinereous pollinose, the occiput bare, shining black; occipito-orbital bristles and two ocellars brownish-yellow; antennal bristles brown; mystax light yellowish, composed of oral bristles, thicker in the middle, and hairs on either side; first antennal segment twice as long as wide, with brown microchaetæ above and bristles below attaining the length of the segment; second three-fourths as long as first, the bristle below a little longer than the first segment; third three times as long as first two combined with the dorsal spine at two-thirds its length, the pubescence very short, leaving the distal portion as small as the proximal portion of the segment.

Prothorax ochreous pollinose, the notum brownish pollinose; collar with pale hairs and fine bristles; mesonotum ochreous pollinose, the geminate middorsal and wide lateral stripe on either side which falls short of the anterior callus, bare, black, finely transversely striated, broadly bordered with brown pollen; clothed with small, inconspicuous, yellowish hairs and a few yellowish

bristles laterally; scutellum with disc bare, with transverse impressions, posteriorly margined with ochreous pollen; pleuræ and metanotum ochreous pollinose; coxæ with cinereous pollen.

Legs light reddish, fuscous at the tips of tarsal segments and with a variable stripe above on femora and anterior tibiæ; vestiture entirely yellowish.

Wings lightly washed with brown, the proximal half tinged with yellow and more nearly hyaline.

Abdomen finely punctate, the punctæ with golden setæ; first segment ochreous pollinose laterad; second to fifth with caudolateral, ochreous pollinose triangles tapering inwardly, narrowly separated dorsad on two to four, widely separated on five.

Known only from type specimens from Omilteme and Sierra de las Aguas Escondidas, Guerrero, Mexico.

Taracticus octopunctatus (Say)

1823. *Dioctria octopunctata* Say, Jour. Acad. Nat. Sci. Philad., iii: 49.

1872. *Taracticus octopunctatus* Loew, Berl. Ent. Zeitschr., xvi: 64.

1904. *Dioctrodes flavipes* Coquillett, Proc. Ent. Soc. Wash., vi: 181.

1907. *Dioctria rufipes* Jones, Trans. Ent. Soc. Amer., xxxiii: 276.

Black; legs yellowish; mesonotum with small yellowish hairs; abdomen with pruinose, caudo-lateral rectangles on segments one to five. Length, 6 to 9 mm.

Pollen of face and frons ochreous; that of rear of head cinereous, occiput very broadly, ocellar tubercle, and most of frons bare, shining black; occipito-orbitals weak, white; mystax white, confined to a row of oral bristles, a few small hairs, and a bristle above on either side; first antennal segment two and one-half times as long as wide, with several yellowish bristles below not over half the length of the segment; second two-thirds as long as first, with a bristle below as long as the segment; third two and one-half times as long as first two combined, tapering distad, with the dorsal spine placed at three-fifths its length.

Prothorax ochreous pollinose with a large bare spot on the pleura; collar with a row of small bristles; mesonotum dark

ochreous pollinose with a geminate middorsal stripe, broadly pollinose at both ends, and two lateral stripes bare and shallowly cross striate; bearing small, yellow hairs, except on the lateral stripe behind the suture, and a few acrosticals; scutellum transversely rugose, with a median stripe and posterior margin cinereous pollinose, the disc with several small yellowish hairs, the posterior margin with a pair of small, distal bristles; pleuræ ochreous pollinose above, cinereous below.

Legs yellowish, distal fifth of hind tibiæ and tips of tarsal segments fuscous; vestiture yellowish.

Wings washed with light brown, tinged with luteous on costal side of proximal half.

Abdomen finely punctate and minutely golden setulose, black, shining, the caudal segment or two, especially in the male, often reddish; side of proximal half of first segment ochreous pollinose; caudo-lateral, cinereous pollinose rectangles on one to five about twice as wide as long.

Known from New Hampshire to Florida west to Texas, Nebraska, and Minnesota. This species is found commonly on the leaves of vegetation in wooded areas.

Taracticus paulus new species

Black; legs yellowish; mesonotum with small, pale hairs; abdomen with caudo-lateral, pollinose rectangles on segments two to five. Length, 7 mm.

Female.—Head pale ochreous pollinose, nearly cinereous behind, the ocellar tubercle for the most part, and a small spot on either side on vertex, bare; vestiture white; mystax a row of stout oral bristles with a smaller bristle and a few small hairs above on either side; first antennal segment two and one-half times as long as broad with the lower bristle below as long as the segment; second two-thirds as long as first with an equally long bristle below; third nearly three and one-half times as long as first two combined, with very fine pubescence, gradually tapering proximad, pointed distad, with the dorsal spine placed just before the middle of the segment.

Pronotum cinereous pollinose with only a small spot at the suture on either side bare; mesonotum pale ochreous pollinose, cinereous on the sides, with a geminate middorsal, a wider lateral stripe divided at the transverse suture, and a spot on the anterior callus bare, black, very minutely, transversely striate; clothed, except on lateral stripes, with small, nearly white hairs and several, especially small middorsals posteriorly, the lateral bristles white; scutellum with a pair of small marginal bristles, the disc bare, transversely rugose, the margin all the way around and a middorsal stripe pale ochreous pollinose; metanotum broadly bare and shining under scutellum.

Legs pale yellowish, the tips of tibiæ and tarsal segments fuscous, especially broad on posterior pair; bristles and hairs pale yellowish.

Wings lightly washed with gray; fourth posterior cell narrowed distad; anal cell nearly closed.

Abdomen black, the sides and caudal two segments reddish, covered with small yellowish hairs set in fine punctæ; side of first segment and caudolateral rectangles on two to five cinereous pollinose, the rectangles three times as broad as long, pointed inwardly, extending well on to the dorsum.

Holotype.—Female, Sacramento, California, July 7, 1936 (A. E. Pritchard), in the collection of the University of Minnesota.

This species is related to *octopunctatus,* differing in having the third antennal segment over three times as long as first two together with the dorsal spine placed before the middle of the segment, in having the occiput and prothorax pollinose, and in having more extensive abdominal markings. The specimen was taken on bean leaves in a cultivated field on the Sacramento River.

THE FOOD OF THE BLACK WIDOW SPIDER ON WHIDBY ISLAND, WASHINGTON

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On Whidby Island, Washington, the Black Widow spider (*Latrodectus mactans* F.[1]) has been found only along the shoreline for a distance of about two miles on the western side of the island opposite the village of Coupeville. Here the land rises from the beach to a height of about 250 feet in a steep, grassy slope, which is well-drained and exposed to the sun. The spiders occur at the base of and on the surface of this slope under pieces of logs or bark.

Continuing the investigation commenced by Exline and Hatch[2] on the food of the Black Widow spider on nearby San Juan Island, the authors collected the remains of 722 individual arthropods from eleven nests: seven in July 1935, two in August 1935, and two in February 1936. These were glued on rectangles of cardboard, about 6.5 mm. wide by 12 mm. long, which were then mounted on insect pins, somewhat after the method employed by Frost[3] in his study of the insect content of frog's stomachs.

Thirty-one species of arthropods, over three-fourths of them beetles, were recognized in this material, which is listed below and which we feel throws some light on the food habits of the spider in this locality. Over half (56%) of the individuals recovered were the tenebrionid, *Coniontis ovalis* LeC., which was likewise the dominant species in the spider's food on San Juan Island. Over forty per cent of the remainder were the carabid, *Harpalus cautus* Dej., with the other species trailing, as indicated in the subjoined list, where the numbers in parentheses indicate the number of individuals of each species taken where that was greater than one. The small number of grasshoppers taken in the nests (five speci-

[1] Presumably the subsp. *hesperus* of Chamberlin and Ivie, Bull. Univ. Utah Biol. Ser. III (1), 1935, p. 15.

[2] Jour. N. Y. Ent. Soc. XLII, 1934, pp. 449–450.

[3] Jour. N. Y. Ent. Soc. XXXII, 1924, pp. 174–185, pl. XIV.

mens of *Melanoplus*)—though grasshoppers are very numerous in this habitat—suggests that one treat critically Strickland's suggestion,[4] based on the finding of eleven specimens of *Melanoplus* in a Black Widow spider nest in Colorado by Milzer,[5] that the abundance of the spider bears any special relation to the abundance of the grasshopper.

On the negative side, our data would seem to show that the Black Widow spider avoids sow bugs, which were likewise very numerous in the area. The remains of only a single specimen of *Porcellio* were found in any of the nests.

Acknowledgments. We are indebted to the following persons for identifications: Mr. James A. G. Rehn and Mr. Morgan Hebard for the *Melanoplus,* Mr. Merton C. Lane for the *Ludius,* Mr. Horace P. Lanchester for the *Cardiophorus,* Mr. W. W. Baker for the *Hyperodes,* Professor Trevor Kincaid for the *Hymenoptera* and *Diptera,* Dr. Harriet Exline Lloyd for the spider. The specimens were prepared for study by Miss Frances Ione Henderson in 1935, employed through funds made available by the United States government for the National Youth Administration.

LIST OF SPECIES

ISOPODA: *Porcellio scaber* Latr.

ORTHOPTERA: *Melanoplus mexicanus bilituratus* F. Walker (5).

DERMAPTERA: *Forficula auricularia* L. (6).

CARABIDÆ: *Carabus tœdatus vancouvericus* Csiki (27), *Notiophilus semiopacus* Esch. (2), *Nebria virescens* Horn, *Pterostichus algidus* LeC. (5), *Amara obesa* Say (18), *A. patruelis subdepressa* Csy., *A. californica* Dej. (2), *A. remotestriata* (20), *A.* near *musculus* Say, *A.* near *cupreolata* Putz., *Calathus ruficollis* Dej. (24), *Harpalus cautus* Dej. (134), *Dicheirus piceus* Men.

MELOIDÆ: *Melœ strigulosus* Mann.

ELATERIDÆ: *Ludius œripennis* Kby. (3), *Cardiophorus tenebrosus* LeC.

BUPRESTIDÆ: *Buprestis adjecta* LeC.

[4] Can. Ent. LXVIII, 1936, pp. 284–285.

[5] Science 80, 1934, p. 403.

TENEBRIONIDÆ: *Eleodes rotundipennis* LeC. (3), *Coniontis ovalis* LeC. (407).

SCARABÆIDÆ: *Serica anthracina* LeC. (41), *Polyphylla decemlineata* Say (2).

CURCULIONIDÆ: *Brachyrhinus ovatus* L., *Phytonomus zoilus* Scap. (5), *Hyperodes* sp.

HYMENOPTERA: *Bremus occidentalis* Greene, *Augochlora radiata* Say (3).

DIPTERA: *Stenopogon longulus* Loew.

ARANEIDEA: *Drassidæ.*

AN OVERLOOKED TITLE BY C. V. RILEY ON THE COLORADO POTATO BEETLE

Through the kindness of Dr. C. H. Hadley, I recently came into the possession of a little book on the Colorado potato beetle by C. V. Riley, entitled "The Colorado Beetle. With suggestions for its repression and methods of destruction." This was printed in London by Bradbury, Agnew & Co., and published in London by George Routledge and Sons in 1877. It is $6\frac{1}{2} \times 4\frac{1}{2}$ inches and consists of 123 pages, bound in so-called "picture boards." In this particular case, the picture is a large colored illustration of the potato beetle. The book appears to be one of a series issued by the publisher and probably sold for a shilling.

This title does not appear in the "Bibliography of the more important contributions to American economic entomology. Part III. The more important writings of Charles Valentine Riley. By Samuel D. Henshaw" (U. S. Department of Agriculture, Division of Entomology, Washington, 1899), and my only reason for mentioning this fifty years after the bibliography was published is that the omission offends (not seriously) my sense of order.

In the New York Tribune for April 1, 1874, March 17, 1875, and April 2, 1875, Riley called attention to the danger of importing *Leptinotarsa decemlineata* into Europe, criticized European articles on the insect, and methods adopted by several European countries to guard against the importation of the beetle and said that the climate of Europe would not be against it.

In 1876 The Orange Judd Company of New York brought out Riley's "Potato pests. Being an illustrated account of the Colorado potato beetle and other insect foes of the potato in North America, with suggestions for their repression and methods for their destruction" (108 p., 49 figs., map). A comparison of the table of contents of this book, as given by Henshaw, with the actual contents of the 1877 London edition leads me to believe that they are more or less identical insofar as the account of the Colorado potato beetle is concerned. H. B. W.

ENTOMOLOGY AND NURSERY RHYMES

By Harry B. Weiss

Although natural history of a sort is found in nursery rhymes and songs, references to insects are quite scarce in the light and frivolous reading matter of infants. Insects, of course, have no place in the nursery and during the early years of children, their imaginations and their romantic inclinations are nourished and satisfied by types of A B C fiction involving objects with which they are familiar. By the time they have become conscious of insects, their interest in nursery rhymes has disappeared.

Nevertheless, a few insects have crept into the nursery and have remained there over the years, exerting perhaps some influence on the fancy of children. In the nursery classic, ''Death and Burial of Cock Robin,'' an unidentified fly and beetle are immortalized.

Who saw him die?
  I, said the fly
  With my little eye—
I saw him die.

Who made his shroud?
  I, said the beetle,
  With my little needle—
I made his shroud.

The most famous of all nursery insects is the lady bird beetle.

Lady bird, lady bird, fly away home,
Thy house is on fire, thy children all gone,
All but one, and her name is Ann,
And she crept under the pudding-pan.

This jingle and variations of it are known to the children of many localities in various countries, and it is said to have first made its appearance in England during the reign of George II. Various substitutes appear for lady bird, such as lady bug, lady cow, lady fly, bonnie bee, etc. A few of the different versions are as follows:

Lady cow, lady cow, fly away home;
Thy house is on fire, thy children all roam,

All but one that lies under a stone.
Fly away lady cow, ere it is gone.

Bless you, bless you, bonnie bee!
Say, when will your wedding be?
If it be tomorrow day
Take your wings and fly away.

Lady-bird! lady-bird! fly away home;
Thy house is a-fire, thy children will roam!
List! List! to their cry and bewailing!
The pitiless spider is weaving their doom,
Then lady-bird! lady-bird! fly away home!
Hark! hark! to thy children's bewailing.

Bishop, Bishop Barnabee,
Tell me when my wedding be:
If it bee tomorrow day,
Take your wings and fly away!
Fly to the east, fly to the wst,
Fly to him that I love best.

The gnat, at least in some parts of England, comes in for some attention from children.

Gnat, gnat, fly into my hat,
And I'll give you a slice of bacon,
And when I bake
I'll give you a cake
If I am not mistaken.

And in the Isle of Wight an old song perpetuates a myth to the effect that dragon flies can distinguish good from bad children when they are fishing.

Snake stanger! snake stanger! vlee aal about the brooks;
Sting aal the bad bwoys that vor the vish looks,
But lat the good bwoys ketch aal the vish they can,
And car'm awaay whooam to vry 'em in a pan;
Bred and butter they shall yeat at zupper wi' their vish,
While aal the littul bad bwoys shall only lick the dish.

This made its appearance in the nursery as—

Dragonfly! dragonfly! fly about the brook;
Sting all the bad boys who for the fish look;
But let the good boys catch all that they can,
And then take them home to be fried in a pan;
With nice bread and butter they shall sup upon their fish,
While all the little naughty boys shall only lick the dish.

In the ''Gentleman's Magazine'' for November, 1806, there appeared for the first time ''The Butterfly's Ball and the Grasshopper's Feast,'' written by William Roscoe for his youngest son Robert. Early in 1807 it was published by John Harris, successor to John Newbery, as the first of his popular series of children's books. It even attracted the attention of the king and queen and was set to music, by Sir George Smart, at their request, for the young princess.

''The Butterfly's Ball,'' in comparison with the current literature for children at that time, was fresh and spontaneous. It was not a dreary, moral tale and it was an immediate success, marking the beginning of a new type of reading matter for children. It also produced a crop of imitations, many of which were inferior.

Its author, William Roscoe (1753–1831) was an attorney, one of the founders of a Liverpool society for the encouragement of the arts of painting and design, a botanist, a poet, a banker, a student of Greek, an author on diverse subjects, etc., etc., and he has three pages devoted to him in the Dictionary of National Biography. By many, however, he is remembered solely as the author of ''The Butterfly's Ball and the Grasshopper's Feast,'' which is herewith reprinted in full.

THE BUTTERFLY'S BALL AND THE GRASSHOPPER'S FEAST

Come take up your hats,
  And away let us haste,
To the Butterfly's Ball
  Or the Grasshopper's Feast.

The trumpeter Gad-fly
  Has summon'd the crew,
And the revels are now
  Only waiting for you.

On the smooth shaved grass,
  By the side of a wood,
Beneath a broad oak,
  Which for ages had stood.

See the children of earth,
  And the tenants of air,
To an evening's amusement
  Together repair.

And there came the Beetle,
So blind and so black,
And carried the Emmet,
His friend on his back.

And there came the Gnat,
And the Dragon-fly too,
And all their relations—
Green, orange and blue.

And there came the Moth
With her plume of down,
And the Hornet with jacket
Of yellow and brown.

Who with him the Wasp,
His companion did bring,
But they promised that evening
To lay by their sting.

The sly litle Dormouse,
Peep'd out of his hole,
And led to the feast,
His blind cousin the Mole.

And the Snail with his horns,
Peeping out of a shell,
Came fatigued with the distance,
The length of an ell.

A Mushroom the table,
And on it was spread,
A water-dock leaf,
Which their table-cloth made.

The viands were various,
To each of their taste,
And the Bee brought the honey
To sweeten the feast.

With steps most majestic,
The Snail did advance,
And he promised the gazers
A minuet to dance.

But they all laugh'd so loud
That he drew in his head,
And went in his own
Little chamber to bed.

Then as the evening gave way
To the shadows of night,

Their watchman the glow-worm
  Came out with his light.

So home let us hasten,
  While yet we can see,
For no watchman is waiting
  For you or for me.

In 1820, Thomas Boys of 7 Ludgate Hill, London, brought out "Chrysallina; or, the butterfly's gala. Addressed to two little girls. In six parts. viz. The ball. The masquerade. The race. The theatre. The tournament. The departure. By R. C. Barton." This little 48 page book of verses ($5\frac{1}{4} \times 4\frac{1}{8}$ inches), intended for children beyond the nursery age, was embellished by an engraved frontispiece and by engravings at the beginning of each part.

These illustrations can hardly be called entomological, although the scenes and characters have entomological touches.

Mr. Wilbur M. Stone, noted collector and bibliophile, permitted me to examine his copy of "Chrysallina," but the text is too long for reproduction here. The first part, entitled "The Ball" is concerned with the court festivities surrounding this function, with the butterfly as queen. A few quotations will enable one to get an idea of how the author handled his subject.

So if you sit still, you shall hear of the call
To the Butterfly's Gala at Chrysalis hall.—
But first you must know, that of insects the queen,
Long the leader of fashion the Butterfly's been.
For like many gay ladies that glitter at court,
She has nothing to do but her beauty to sport,
No children to nurse, and no husband to cherish,
The poor may go hungry, the sickly may perish,
As long as she flutters, and basks in the sun,
She cares not who dies, and p'rhaps laughs at the fun.

After dwelling upon the capriciousness and tyranny of the queen and of the homage she expected, the author has the queen announce a fete on her birthday, the first of May, to continue a week and so on that day the affair began.

The insects from every retreat were approaching;
Regardless of friends, or on neighbors encroaching;
Some flying, some creeping, some waddling in haste,
Each bringing some proof of their genius or taste.

* * * * *

* * * * *

As that hour drew near, in her boudoir was seen,
In magnificent splendour, the Chrysalline queen;
A moss rose sustain'd her fair majesty's throne,
On which she reclined with a grace all her own.
The violet her footstool, while over her head
The geranium's broad leaf a green canopy spread:
And scatter'd around in a most graceful display
All the sweets of the garden promiscuously lay.

The queen was attended by her suite which discussed politics and the weather. Six lady birds were maids of honor and her pages were grasshoppers, lizards and flies, "all of elegant form but diminutive size."

Her physicians were Black-beetles, pompous and proud;
And the fav'rite an Ear-wig is always allow'd;
Her heralds were Gnats, with their horns to proclaim
Through the staircase and hall each illustrious name.

A lady spider brought the queen a cobweb; Mrs. Moth brought a wonderful load, the jewel she had found in the head of a toad. A dashing young grasshopper kissed the queen's hand, and other insects entered and paid their respects to her. Five hundred glowworms attended the queen and illuminated the lawn where the dance was held. Music was furnished by canary birds, bullfinches, linnets and thrushes. The queen danced with young ear-wigs, grasshoppers with lady birds, and so on.

The next evening there was a grand masquerade. For this, thousands of fireflies supplied the illumination, as the glowworms were tired out by their work on the previous evening.

The succeeding days and nights were occupied by such activities as races, amateur theatricals, and tournaments, all participated in by insects, and the last lines are devoted to the departure of the insects to their normal homes and activities.

The entire poem is really a sort of pleasant satire on court displays, diversions, and social activities even though written as something new to please young people.

During the first half of the nineteenth century "Baby-Bye," with its glorification of the housefly, was a popular piece in the "readers" of that period. This, of course, was long before the

housefly was renamed the "typhoid fly" by some writers, and long before numerous pathogenic bacteria had been isolated from it.

Nowadays, a mother, at least an entomological mother, would shudder if she saw this purveyor of filth, bacteria, protozoan cysts, and helminth eggs, this wallower and feeder in fecal matter, this hairy vomiting distributor of 500,000,000 bacteria, tickling *her* baby's nose. And who would blame her? However, here is "Baby-Bye," an enlivening little thing from a benighted age.

BABY–BYE

1. Baby-Bye
Here's a fly
We will watch him, you and I.
How he crawls
Up the walls
Yet he never falls!
I believe with six such legs
You and I could walk on eggs.
There he goes
On his toes
Tickling Baby's nose.

2. Spots of red
Dot his head;
Rainbows on his back are spread;
That small speck
Is his neck;
See him nod and beck!
I can show you, if you choose,
Where to look to find his shoes,
Three small pairs,
Made of hairs;
These he always wears.

3. Flies can see
More than we
So how bright their eyes must be!
Little fly,
Ope your eye;
Spiders are near by.
For a secret I can tell,
Spiders never use flies well;
Then away,
Do not stay.
Little fly, good day.

PROGRESS OF JAPANESE BEETLE INVESTIGATIONS

By C. H. HADLEY
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Investigations of the Japanese beetle (*Popillia japonica* Newman) were begun by the Bureau of Entomology in 1917, following the discovery of the insect near Riverton, N. J., in August 1916. At first, efforts were centered chiefly upon an attempt to exterminate the infestation and to acquire a general knowledge of the life history and habits of the insect, but as soon as it became evident that the beetle could not be eradicated, the investigation was directed toward control and reduction of damage. With this objective the following lines of research have been carried on: (1) Obtaining a full and intimate knowledge of the insect's habits and reactions to its environment; (2) development and perfection of measures to prevent material damage by the insect in any of its stages to economic plants and crops; (3) development of practical and economical methods for insuring freedom from infestation of commercially grown nursery stock and agricultural products, to prevent widespread distribution of the insect throughout the United States; and (4) introduction of predacious and parasitic enemies of the beetle from the Orient and their dissemination throughout the infested areas.

It is the purpose of this paper to review briefly some of the results accomplished by the investigation and to refer to the major lines of study under way at the present time.

A full account of the life history and habits of the beetle under conditions obtaining in the older infested area has been published (*17*)[1] The development of the beetle in the more recently invaded areas is being studied as opportunity is offered, to observe its reaction to the different environment conditions.

The probable ultimate distribution of the beetle in the North American Continent is a matter of much interest. While as yet

[1] Italicized numbers in parentheses refer to Literature Cited.

no certain prediction can be made of its ultimate range, studies carried over a period of years of the climatic adaptability of the insect, supplemented by a critical comparison of the outstanding climatic features of the United States with those of Japan, suggest the probability that the Japanese beetle will find climatic conditions in general adapted to its permanent establishment in those sections of the eastern half of the United States where the normal temperature and precipitation most closely approach those of Japan. Generally speaking, this region extends in the Eastern States from the Canadian border south to central South Carolina and northern Georgia, and in the Central States from the southern peninsula of Michigan, southern Wisconsin, and central Iowa to northern Alabama, Louisiana, and northeastern Texas. A combination of the low winter temperature, normal to the northern interior, with an absence of snow, would possibly preclude permanent colonization by the beetle in the region west of the Great Lakes. On the other hand, no obvious barrier exists to the ultimate southward extension of its range to Florida and the entire Gulf coast, although in the light of certain facts in the life cycle of the insect as influenced by temperature and summer rainfall, there exists the bare possibility that its spread in the extreme southern sections of this country may prove difficult than would be antecedently expected.

The investigations relating to the development of control measures may be divided conveniently for the purpose of this discussion into three phases, as follows: Control of the adult beetle; control of the immature stages; and methods for growing, handling, or treated nursery stock and agricultural products to insure their freedom from infestation prior to the shipment of these commodities in ordinary commerce.

Control of the adult beetle. During the early years of the investigation it was noted that certain plants were especially attractive to the beetle, and the outstanding attractiveness of geraniol was discovered. This positive attraction of geraniol was utilized in the development of the first beetle trap in 1924, which used a combination of geraniol and eugenol as the attractant. Studies have been continued since that time to improve the effectiveness of the trap. Particular attention has been directed toward the

structural features of the trap in order to increase its efficiency and reduce the cost of manufacture. Studies have also been made to determine to what extent the color of the trap influences its efficiency and to determine the best types or combinations of bait. Of the large number of colors and color combinations tested, it has been definitely established that traps painted green and white are superior to those of any other color. Extensive studies of geraniol have been made (*25*), as a result of which standard specifications have now been drawn up for a much cheaper grade of geraniol than heretofore recommended, but having equal attractiveness. It has recently been found that the addition of phenylethyl alcohol to the geraniol-eugenol combination still further increases the attractiveness of this bait without materially increasing the cost. The solid bait previously recommended, in which the attractants were mixed with bran or other similar materials, has been replaced by the geraniol-eugenol combination in liquid form, dispensed by means of a wick, or vaporized from cakes of pumice or clay which have been impregnated with the attractants. The type of trap now recommended, with the improved bait mixture (*23*), will catch approximately 40 times as many beetles under the same operating conditions as the original trap. Public service patents (Nos. 1,968,953 and 1,968,954) covering two of the latest types of beetle traps have been granted to F. W. Metzger, of the laboratory staff.

It was early recognized that the Japanese beetle is repelled to a large extent by the presence of many toxic and nontoxic white materials on fruit and foliage. The use of lead arsenate with a suitable sticker, such as fish oil or ordinary wheat flour, has been recommended for a number of years for the protection of late ripening apples, peaches, and other tree fruits and the foliage of ornamental trees and shrubs, but because of the residue remaining at the time of harvest arsenicals should not be used on early ripening fruits or under other conditions where poisonous residues would be objectionable.

Many materials have been tried, either alone or in combination, as substitutes for lead arsenate for fruit and foliage protection (*4, 7*). It has been found that derris containing 4 to 5 per cent of rotenone is a definite repellent to the Japanese beetle (*12*), the

repellent action appearing to be due primarily to the rotenone and deguelin content of the material, although neither of these constituents is any more repellent than derris when used alone. However, derris decreases rapidly in effectiveness upon exposure to sunlight and is readily washed from the fruit and foliage by rain, and even by heavy dews. The emulsified residue from rosin stills has been found to be a cheap and effective sticker for use with derris, and it does not accelerate the decomposition of derris in sunlight (*16*). The use of the derris and rosin residue is now being recommended as a repellent spray for early ripening peaches (*14*), although the application must be repeated at weekly intervals during the height of the beetle season to obtain satisfactory protection. This development is of particular importance, as it is the first time that it has been possible to recommend a material for the protection of early ripening peaches which does not leave any objectionable residue on the fruit at the time of harvest. The results of studies now in progress are such as to warrant the belief that the decomposition of the derris can be materially retarded so that the number of sprays required to give adequate protection can be decreased.

It has also been known for several years that applications of hydrated lime afford a considerable degree of protection to fruit and foliage, but the poor adhesive quality of this material makes its extensive use impractical. To overcome this difficulty, studies have been made of different oils, gums, and other materials as stickers for lime, and it has been found (*24*) that the addition of aluminum sulfate to hydrated lime forms a spray solution which leaves a residue on the foliage that is very repellent to the beetles throughout the entire season. This cheap, nontoxic repellent spray is now being recommended (*14*) for use in commercial apple orchards and on ornamental trees and shrubs growing under conditions where the use of arsenical sprays is not desirable.

In commercial greenhouses in the generally infested areas, the adult beetle does considerable damage to roses by emerging during the winter months and feeding on the buds and blooms. A method has been developed for applying lead arsenate to the soil of the beds in the greenhouses, which destroys the larvæ without

impairing the quality or quantity of the plants and blooms (*22*). Further experience with this method shows that it is possible to maintain a practically complete grubproof condition in the treated houses for at least two years, and possibly longer.

Japanese beetles, when present in large numbers, have caused considerable injury to certain crops, such as sweet corn, asparagus, and rhubarb. It has been found that injury to sweet corn can be reduced by dusting with 300-mesh hydrated lime at the rate of 100 pounds to the acre, applying the dust directly upon the developing silk. Preliminary studies have shown that asparagus brush and rhubarb can be protected to some degree by the application of lime and aluminum sulfate. Additional data are necessary, however, before unqualified recommendations of this method can be made.

Control of immature stages. In areas where the beetle population is very dense, larval populations as high as 40 to 50 per square foot are not infrequent and often cause extensive damage to turf as well as to various crops.

In connection with the investigations to find means of destroying larvæ in the soil, it is necessary to determine rather accurately the average concentration of larvæ in a given field. It has been found that the most accurate estimate can be made with the least labor by examining 1 percent of a given area, using 1 square foot as the unit for examination (*11*). The error of the estimate is influenced by the density of the population and the proportion of the field examined.

Larvæ have proved to be serious pests in cultivated turf of lawns, cemeteries, parks, and golf courses. They feed on the roots of the grass immediately below the surface and when in large numbers will cause injury ranging from 50 percent to total destruction. It has been found that the density of a larval population sufficient to cause damage to turf is not always the same, but is dependent on the type of grass, the condition of the soil, the amount of moisture, the availability of plant food, and other factors going to make up a favorable environment. The most satisfactory treatment for the protection of turf is the application of lead arsenate at the rate of 10 pounds to 1,000 square feet of turf area (*5, 15*). This treatment is now common practice throughout the generally infested area. The permanence of the

treatment will depend upon many factors, but in general the turf can be kept immune from injury for at least five years by one application of the lead arsenate at the recommended rate.

In connection with the studies on the application of lead arsenate to soil in nurseries and to turf, an extended study has likewise been made of the rate of penetration into and movement of the arsenate through the soil and the effect of various soil types and conditions upon the poison (*10, 13*). In general, it has been found that, under conditions where leaching is a negligible factor, the various arsenates gradually lose their effectiveness in killing the larvæ in the soil. This decrease in effectiveness can probably be attributed to the slow conversion of the arsenic into a form that is not toxic to the larvæ. The effectiveness of lead arsenate as an insecticide varies in different types of soil, the variation being correlated principally with the amount of water-soluble phosphates, ammonia, and magnesium present in the soils. The pH of the soil and the water-soluble manganese, calcium, potash, chlorides, and nitrates appear to have little influence on the insecticidal action. Further studies have shown that the light sandy soils have practically no power to fix arsenates and that the arsenic is gradually lost from the surface layers. In the heavier clay loams and silt loams there appears to be a definite tendency for arsenic to accumulate in the surface layers and to become fixed. There is a wide variation in the susceptibility of different plants to arsenic in the soil. Some plants are readily injured, whereas others appear to be quite tolerant. The age of the plant also seems to be a factor. The effect of arsenic on a plant is governed by the concentration of soluble arsenic in the soil rather than by the total amount of arsenic present. The use of such stomach poisons as lead arsenate cannot be recommended for destruction of the larvæ in the soil in which truck or vegetable crops are being grown because of the absorption of the arsenic by the plants.

Studies on the effectiveness of cultural practices for control of the larvæ have shown that an average reduction of 28 percent can be obtained by the usual plowing and disking with ordinary cultural equipment. This reduction, however, is generally not sufficient to prevent extensive damage to crops in heavily infested

areas. It has been found, in cooperation with the Bureau of Agricultural Engineering of the United States Department of Agriculture, that implements of the roto-cultivator type will effect a 70 to 90 percent reduction in the larval population. This type of equipment offers promise for control, and further studies are being continued along this line.

Methods for growing, handling, or treating nursery stock and agricultural products to insure their freedom from infestation prior to shipment. Nursery stock and many agricultural products are commonly grown under conditions in which it is impractical to prevent them from becoming infested. In order that these commodities may be shipped to points outside the regulated areas in compliance with the requirements of the Japanese beetle quarantine, various methods of destroying infestation have been developed. The carrying out of these methods has been accepted as a basis for certification for such movement (*27*).

It has been found that submersion in hot water at a temperature of 112° F. will destroy the infestation in certain perennial plants (*6*). Dips of carbon disulfide emulsion have also been found effective in this connection and are useful for the treatment of individual trees and other nursery stock in small quantities in the nursery rows. Carbon disulfide (*9*) and naphthalene (*8*) have been found effective for the fumigation of potting soil, compost, manure, and other similar materials which are used for growing plants under conditions where the soil is protected from reinfestation. Paradichlorobenzene has recently been found to be effective as a fumigant for destroying the larvæ in soil about the roots of azaleas, and experiments are being continued to determine whether the treatment can be applied safely to other plants.

The carbon disulfide field treatment was found to be inadequate for treating the large blocks of evergreen stock commonly grown in commercial nurseries within the infested area. A practical procedure for destroying infestation of larvæ in the field under these conditions consists in applying lead arsenate prior to July 1 at the rate of 1,500 pounds per acre, and working it uniformly into the soil to a depth of 3 inches. Plots treated in this manner are free from infestation from October 1 until June

15. Treated plots can be maintained indefinitely free of infestation by analyzing the soil for arsenic each spring and adding prior to July 1 the quantity of lead arsenate necessary to restore the arsenical content of the soil to the required concentration. This procedure has been accepted as an approved method for certification (*27*), and is extensively used by commercial nurseries producing large quantities of field-grown stock.

Blueberries, blackberries, raspberries, and other fruits become infested with adult beetles during the process of harvesting and packing for shipment; bananas are infested during their transfer from boats to refrigerator cars. Methods have been developed for fumigating these fruits with calcium cyanide, liquid hydrocyanic acid, carbon disulfide, or ethylene oxide (*26*). Studies are being continued to determine the possibility of applying these treatments to other agricultural commodities.

The possibility of biological control of the Japanese beetle through the agency of predacious and parasitic enemies has been given a great deal of attention, with respect both to native species of parasites or predators normally attacking white grubs and to those species known to attack the beetle in its native habitat, the Orient.

Native insect parasites and predators of white grubs appear to play only a minor rôle in the control of the Japanese beetle in the general Philadelphia area, in spite of the fact that the beetle has been abundant in this area for many years. With the exception of *Tiphia intermedia* Mall., which parasitizes sporadically only a small fraction of 1 percent of Japanese beetle larvæ, no native tiphiids or scoliids have been observed attacking *Popillia.* The predatory groups, such as the carabids, therevids, tabanids, asilids (*18*), and the formicids, prey upon *Popillia* larvæ when contact is made. However, the normal population of these predators in the present areas of infestation is not sufficient to cause any marked decrease in the *Popillia* population, nor has there been observed any marked increase in the population of these predators due to the increased food supply, as represented by the presence of *Popillia* larvæ in great abundance.

On the other hand, the possibility of a reasonable degree of biological control of the beetle in the future through the agency

of its introduced parasites presents a much more helpful picture. The status of parasitic control of *Popillia* in the Orient has been intensively studied (*2, 3*), and to date some 17 species have been imported and liberated in the generally infested area. Of these, however, only five species and one racial form, representing two orders, the Diptera and the Hymenoptera, are known to be definitely established.

The dipterous group, which includes *Centeter cinerea* Ald., *Dexia ventralis* Ald., and *Prosena siberita* Fab., as a whole has not proved to be so promising as had been anticipated. These species are but feebly established, owing in part at least, to climatic differences between their old and new environments, changes in the life cycle of the host, and lack of necessary alternate hosts (*20*). *Centeter* is at present distributed over an area of about 252 square miles in the center of the beetle-infested territory. However, it is not entirely synchronized with its host within this area, and the percentage of parasitization, while high at some points at the beginning of the season, drops to a negligible point when the host appears in the field in abundance. Experiments with southern Japanese strains of *Centeter* to improve synchronization with its host have given negligible results in the latitude of heavy beetle infestation. *Dexia* is still represented by only one feebly established colony near Haddonfield, N. J., where a low, moist soil holds a small fraction of the host larvæ through the critical summer season, thus making them available for the second, or summer, generation of the parasite. Laboratory experiments, however, have shown that *Dexia ventralis* will attack native *Phyllophaga* larvæ, and attempts have been made to establish it in an area in Illinois heavily infested with *Phyllophaga* species. Colonies of *Dexia* have been released near Elkton, Md., in an area inhabited by both *Popillia* and native *Phyllophaga.* While as yet no recoveries of *Dexia* have been made at either of these points, the failure to make recoveries does not necessarily indicate that the species has not survived, as sufficient time may not have elapsed for the survivors to have increased to a point where they can be detected. *Prosena siberita* was originally recovered in 1926, but has since remained in a feeble state of establishment in the Moorestown, N. J., area. This species is

handicapped by having only a single generation per year, which is not entirely synchronized with the cycle of *Popillia* in the present area of heavy infestation. It may be more useful in northern areas where *Popillia* will have a two-year cycle, and releases will be made in such areas when the host population becomes sufficiently extensive to warrant liberation.

The hymenopterous parasites are represented by the genus *Tiphia,* of which two species and one racial form are now well established, all larval parasites of *Popillia japonica. Tiphia popilliavora* Roh. has been colonized with locally collected material since 1927 (*21*), and to date colonies have been liberated at 513 points in the generally infested area. Of these, 134 liberations were made during the 1935 season. During 1932-33 a survey of 194 of the points of liberation showed that colonies were established at 114 points, representing a 59 percent establishment. Many of the recovered colonies have built up extensively and spread over considerable areas. For several seasons collections have been made from some of the stronger colonies for field liberation, 13,400 females having been collected from two colonies during the summer of 1935.

It has been observed that the *Tiphia popilliavora* population fluctuates considerably at irregular periods, owing to the seasonal fluctuations of its host. A late emergence of *Popillia* throws the predominance of early second-instar host larvæ into the active oviposition period of the parasite, thus creating a less favorable condition for parasite development, as early second-instar host larvæ are less favorable for the parasite than more mature larvæ. To overcome this difficulty, racial strains of *Tiphia popilliavora* having a marked later seasonal period of activity have been brought in from the Orient. A strain from Chosen (Korea), which normally appears a month or more later than the present established Japanese strains, was liberated at two points in 1934 and recoveries were made from both in 1935; additional releases were made during 1935 at nine points. Five colonies of a second group of late *Tiphia popilliavora* strains from the general vicinity of Yokohama, Japan, were also released during 1935, but it is too soon to determine the results.

The other *Tiphia* species, *T. vernalis* Roh., which was first

established in 1926 from material imported from Chosen, has also been successfully colonized (*1*). To date (January 1936) liberations have been made at 493 colony centers, for the most part within the area of heavy beetle infestation, and all but 108 of these were from material collected from the earliest established colonies. The extent of establishment is indicated by the fact that 154 colonies of 100 females each were placed in the field during 1934 and 141 colonies in 1935, all field collected from established local colonies. Scouting has shown that about 53 percent of the colonies released are established. A survey made during the latter part of June 1935, at a colony liberated in 1931, showed that, with a host population of 5.2 larvæ per square foot, the parasitization was 67 percent[2]. While this is an unusually high degree of parasitization and is probably far above the normal, it is indicative of the fact that *Tiphia vernalis,* when properly synchronized with its host, should be an effective parasite of *Popillia.*

One of the more important phases of the biological control investigations now in progress is the study of the relationship of soil micro-organisms to the larval population of the Japanese beetle, undertaken in cooperation with the New Jersey Agricultural Experiment Station. The purpose of the study is to determine what organisms in the soil have a definite relationship to the immature stages of the beetle, the extent to which this relationship influences the seasonal fluctuation of the larval population, and the practical utilization of any of these organisms in the reduction of infestations on a large scale.

Four groups of diseases causing mortality of Japanese beetle larvæ have thus far been encountered: (1) The "white" group, probably of bacterial origin, characterized by the whiteness of infected larvæ and the milky appearance of their blood, with the bodies becoming brown after death; (2) the "black" group, in which the bodies of diseased larvæ become brown or black; (3) the fungus group; and (4) the nematode group, of which several apparently distinct species have been found attacking larvæ (*19*). The white group now appears to be the most important, the mor-

[2] Average of 200 square-foot diggings in a plot of 10,000 square feet, representing an examination of 2 per cent of the total area of the plot.

tality of larvæ from this cause being higher than with any of the other types of disease. There are two, and possibly three, similar yet distinct organisms involved in diseases of the white group, and because of the milky consistancy of the blood of affected larvæ these diseases are spoken of as ''milky'' diseases. They are present in the larval population throughout the year, but reach their peak in June in mature larvæ just prior to pupation. At this time approximately 25 percent of the larvæ at certain stations under observation in 1935 were diseased. Milky diseases are infectious and in the field are transmitted by organisms left in the soil by larvæ killed by disease. These diseases are present at most of the places longest infested by the Japanese beetle, but they have not been found at several places more recently infested. Studies are now under way to determine the feasibility of introducing these diseases at points where they do not now occur, and of their utilization in large-scale reduction of larval populations.

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THE APHID GENUS PSEUDŒPAMEIBAPHIS[1]

BY G. F. KNOWLTON AND C. F. SMITH[2]

This study is based upon an examination of approximately six hundred specimens, comprising five species.

Gillette and Palmer. Ann. Ent. Soc. Amer. 25 : 145. 1932.

The genus *Pseudœpameibaphis* Gillette and Palmer may be characterized as: Vertex nearly flat; frontal tubercles absent; ocular tubercles rudimentary; fan-shaped to blunt hairs; cornicles slender, slightly swollen distally on inner side, impinged against abdomen, and with thin-edged flange set obliquely; cauda rather conical; wing venation as in the genus *Aphis*. Genotype *Aphis tridentatæ* Wilson.

KEY TO APTERA

A.—Hind tibiæ less than 2 × unguis; unguis more than 2½ × base ....*glauca*

AA.—Hind tibiæ more than 2 × unguis; unguis less than 2½ × base.

B.—Unguis 2 or more times III .... *essigi* n. sp.

BB.—Unguis less than 2 × III.

C.—Cornicles less than 2½ × III.......... *tridentatæ*

CC.—Cornicles more than 2½ × III.

D.—Cauda not longer than rostral IV + V; abdominal segment VIII nearly covering cauda ..*xenotrichis* n. sp.

DD.—Cauda longer than rostral IV + V; cauda visible from above .... *zavillis* n. sp.

Pseudœpameibaphis tridentatæ (Wilson)

Wilson, Trans. Amer. Ent. Soc. 51 : 94–95, 1915.

Alate vivipara.—Body 0.86 to 1.2 mm. long to base of cauda; antennæ 0.8 to 1.02; antennal III, 0.15 to 0.17 mm. long and bearing 3 to 5 oval sensoria; IV, 0.11 to 0.17; V, 0.13 to 0.17; VI, 0.1 to 0.11 + 0.22 to 0.28; rostrum attaining second coxæ; rostral IV + V, 0.125; hind tibiæ 0.53 to 0.62; hind tarsi 0.049 to 0.125; cornicles 0.17 to 0.22; cauda 0.078 to 0.094 mm. long.

Apterous vivipara.—Body 1.16 to 1.36 mm. long to base of cauda

[1] Contribution from the Entomology Department, Utah Agricultural Experiment Station, Logan, Utah.

[2] Associate Entomologist and Graduate Research Assistant, respectively. Authorized for publication by Director.

and bearing numerous blunt to flattened hairs 0.031 to 0.053 mm. long on the abdomen; hairs on vertex 0.034 to 0.094; antennæ 0.66 to 0.85; antennal III, 0.11 to 0.16; IV, 0.09 to 0.14; V, 0.1 to 0.157; VI, 0.08 to 0.11 plus 0.17 to 0.25; rostrum nearly attaining third coxae; rostral IV + V needle-like, 0.11 to 0.14; tibial hairs pointed to blunt on the outer side and 0.045 to 0.056; tibial hairs on the inner side pointed and 0.024 to 0.04 mm. long; hind tibiæ 0.38 to 0.62; hind tarsi 0.1 to 0.14; cornicles pale, 0.21 to 0.28; cauda 0.08 to 0.125 mm. long.

Taxonomy.—*P. tridentatæ* differs from *P. glauca* in having body hairs more flattened and more numerous; in having tibiæ more than twice unguis; longer body hairs; and in having ungis less than twice antennal III.

Collections.—All collections were on *Artemisia,* the usual species being *tridentata.* Amalga, May 12, 1928; Beaver Dam, May 25 and June 3, 1927; Blue Creek, May 25, 1927; Blue Springs Hills, May 19, 1930; Butlerville, April 25, 1936; Camp Williams, May 9, 1936; Cedar Fort, May 10, 1936; Cedar Valley, May 12, 1936; Chester, May 7, 1927; Collinston, May 12, 1930, and June 3, 1927; Deweyville, April 28, 1927; Ephraim, May 7, 1927; Fillmore, April 28, 1935; Hansel's Mountains, May 19, 1930; Honeyville, April 28, 1927; Howell, May 25, 1927; Juab, April 28, 1935; Lampo, May 25, 1927; Lewiston, May 25, 1935; Levan, May 13, 1936; Logan Canyon, July 4, 1936; Manti, May 7, 1927; Mapleton Bench, May 10, 1936; Moroni, May 7, 1927; Park Valley, May 24, 1930; Promontory, May 25, 1927; Plain City, May 11, 1928; Rattle Snake Pass, May 25, 1927; Snowville, May 25, 1927; Salt Lake City, June 5, 1927, and April 25, 1936; Spring City, May 7, 1927, in Utah. Also Jackson Hole, Wyoming, June 12, 1936. *Alate vivipara* were collected at Beaver Dam, June 3, 1927; Levan, May 13, 1936; Park City, June 15, 1927; Hardup, June 9, 1930, in Utah.

Pseudoepameibaphis essigi new species

Apterous vivipara.—Whitish-yellow to orange-green covered with numerous blunt to fan-shaped hairs which are 0.024 to 0.038 mm. long on the abdomen and 0.034 to 0.049 mm. long on the vertex; body small, 0.75 to 1.0 mm. long; antennæ 0.42 to 0.63 mm. long, pale, except unguis which is slightly dusky; antennal III, 0.063 to 0.089; IV, 0.045 to 0.086; V, 0.07 to 0.096; VI, 0.06 to 0.095 + 0.13 to 0.173; rostrum acute, scarcely attaining 3rd coxæ; rostral IV +

V needle-like, 0.08 to 0.1; hind tibiæ 0.27 to 0.376 mm. long and bearing flattened to fan-shaped hairs 0.03 to 0.038 mm. long on the outer side and blunt to pointed hairs on the inner side 0.02 to 0.026 mm. long; cornicles pale, 0.12 to 0.17 mm. long; cauda pale, 0.069 to 0.086 mm. long.

Taxonomy.—*P. essigi* differs from *P. tridentatae* in being noticeably smaller, having stouter and more numerous hairs, in having the unguis 2 or more times longer than III, and in having the outer tibial hairs shorter and stouter. *P. essigi* differs from *P. glauca* in being much smaller, having stouter and more numerous hairs, tibiæ more than twice unguis; antennal V longer than IV, usually longer than III; and in having shorter and stouter outer tibial hairs. *P. essigi* has been collected very frequently upon the same plant with *Flabellomicrosiphum tridentatae* (Wilson).

Collections.—All collections were made on *Artemisia,* the usual species being *tridentatæ.* Type locality, 3 miles southwest of Lampo, August 1, 1936 (Knowlton : : Smith) ; Amalga, October 4, 1927 (Knowlton) ; Bear River City, September 11 and 25, 1926 (Knowlton) ; Beaver, August 8, 1936 (Knowlton : : Smith) ; Bert, August 1, 1936 (Knowlton : : Smith) ; Blue Creek, August 1, 1936 (Knowlton : : Smith) ; Bryce Canyon, August 10, 1936 (Knowlton : : Smith) ; Bryce Canyon, August 10, 1936 (Knowlton : : Smith) ; Cornish, August 9, 1927 (Knowlton) ; Grouse Creek, August 13, 1932 (Knowlton) ; Howell, June 17, 1930 (Knowlton), and August 1, 1936 (Knowlton : : Smith) ; Junction Valley, August 13, 1932 (Knowlton) ; Laketown, July 5, 1935 ; Levan, August 7, 1936 (Knowlton : : Smith) ; Nephi, August 7, 1936 (Knowlton : : Smith) ; Orton, August 10, 1936 (Knowlton : : Smith) ; Parowan, August 8, 1936 (Knowlton : : Smith) ; Portage, August 20, 1927 (Knowlton) ; Promontory, August 1, 1936 (Knowlton : : Smith) ; Rattle Snake Pass, August 2, 1932 (Knowlton) ; Thatcher, August 1, 1936 (Knowlton : : Smith) ; Themonton, September 25, and August 28, 1926 (Knowlton) ; Tropic, August 10, 1936 (Knowlton : : Smith) ; in Utah. Also collected at Palisades, Colorado, August 24, 1935 (Knowlton) and at Strevell, Idaho, August 25, 1932 (Knowlton).

Type slide in the U. S. National Museum. Paratypes in collections of writers.

Pseudœpameibaphis glauca G. and P.

Gillette and Palmer, Ann. Ent. Amer. 25: 145–146, 1932.

Apterous vivipara.—Body 1 to 1.4 mm. long to base of cauda and bearing numerous blunt to flattened hairs 0.038 to 0.06 mm. long on the abdomen; hairs on vertex 0.045 to 0.069; antennæ 0.66 to 1.11; antennal III, 0.11 to 0.19; IV, 0.1 to 0.18; V, 0.1 to 0.17; VI, 0.08 to 0.11 + 0.19 to 0.36 mm. long; rostrum nearly attaining third coxæ; rostral IV + V needle-like at tip and 0.12 to 0.14 mm. long; tibial hairs pointed to blunt on the outer side and 0.053 to 0.065; tibial hairs on the inner side pointed and 0.02 to 0.032 mm. long; hind tibiæ 0.38 to 0.6; hind tarsi 0.09 to 0.125; cornicles pale, 0.235 to 0.34; cauda 0.08 to 0.125 mm.

Alate vivipara.—Body 0.92 to 1.4 mm. long to base of cauda; antennæ 1.1 to 1.3; antennal III, 0.2 to 0.28 mm. long and bearing 5 to 8 sensoria; IV 0.2 to 0.23; V, 0.19 to 0.22; VI, 0.11 to 0.125 + 0.36 to 0.42; rostrum attaining 2d coxæ; rostral IV + V, 0.125 to 0.14; hind tibiæ 0.64 to 0.74; hind tarsi, 0.11 to 0.14; cornicles 0.26 to 0.28; cauda 0.078 to 0.094 mm. long.

Collections.—All collections were on *Artemisia,* the usual species being *tridentata.* Ash Creek Canyon, August 9, 1936; Beaver Dam, June 7, 1932; Mouth Big Cottonwood Canyon, July 10, August 5, 1936, and August 22, 1935; Brigham City, June 17, and July 19, 1927, and July 2, 1936; Cache Junction, May 17, 1927; Collinston, April 28, 1927; Cornish, June 27, 1935; Deweyville, April 28, 1927; Dry Lake, August 10, 1927; Garland, August 1, 1936; Granite, July 15, 1936; Green Canyon, July 15, 1936; Hillsdale, August 10, 1936; Hobble Creek, June 24, 1936, July 15, 1936; Honeyville, April 28, May 17, June 17, and 21, July 19, 1927; Laketown, August 16, 1927; Logan Canyon, August 20, 1925; Maple Canyon, June 7, 1935; Mantua, June 26, 1936; Mueller's Park, July 2, 1935; Newton, October 9, 1927; Ogden, August 12, 1936; Payson, August 7, 1936; Sardine Canyon, July 10, 1935, June 26 and July 2, 1936; Scipio, July 7, 1925; Summit, Iron County, May 2, 1934, in Utah. Also collected at Steamboat Springs, August 18, 1935; Pingree Park, August 21, 1935; and Kremling, August 24, 1935, in Colorado. In Idaho at Emigration Canyon, August 16, 1927; Mink Creek, June 27, 1936; Rexburg, June 16 and 23, 1935; Riverdale, July 24, 1936; Upper

Sand Creek, June 13, 1936; and Winder, June 9, 1935. In Wyoming at Afton, Alpine, and Etna, July 19, 1936; Fishing Bridge, Yellowstone National Park, July 18, 1936. In Montana at Crown Springs, Fort Ellis and Livingston, July 17, 1936; 10 miles southwest of Nehart, June 11, 1936; and Yanky Jim Canyon, July 17, 1936. *Alate vivipara* were collected at Brigham City, June 17, 1927; Dry Lake, August 19, 1927; Honeyville, June 17 and 21, 1927, in Utah.

Pseudoepameibaphis xenotrichis new species

Apterous vivipara.—Greenish overcast with whitish; body 1.0 to 1.2 mm. long to base of cauda and bearing numerous flattened to fan-shaped hairs 0.024 to 0.04 mm. long on the abdomen; hairs on the vertex 0.04 to 0.05; antennæ 0.5 to 0.61; antennal III, 0.09 to 0.11; IV, 0.07 to 0.08; V, 0.09 to 0.1; VI, 0.075 to 0.08 + 0.13 to 0.15; rostrum surpassing second coxæ; rostral IV plus V, 0.094; tibial hairs flattened to slightly fan-shaped on the outer side and 0.024 to 0.035 mm. long; on the inner side pointed and 0.024; hind tibiæ 0.35 to 0.41; hind tarsi 0.08 to 0.095; cornicles 0.26 to 0.34; cauda 0.07 to 0.08 mm. long.

Taxonomy.—*P. xenotrichis* differs from *P. tridentatæ*, *P. essigi* and *P. glauca* in having more numerous hairs and in having the hairs much more fan-shaped on the body and the outer side of the tibiæ; in having the eighth abdominal segment superimposed over the cauda.

Collections.—On *Artemisia tridentata* at Brigham Canyon (type locality); Perry, and Sardine Canyon, July 8, 1933, in Utah (Knowlton).

Type slide in the U. S. National Museum. Paratypes in collections of writers.

Pseudoepameibaphis zavillis new species

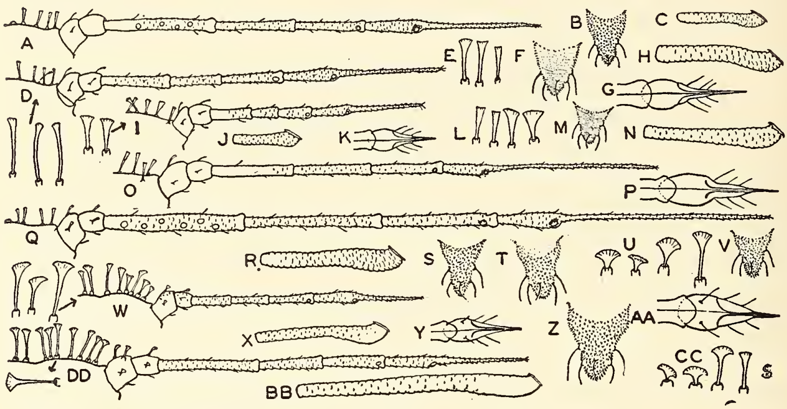
Apterous vivipara.—Greenish-pulverulent, body 1.5 to 1.75 mm. long to base of cauda and bearing numerous flattened to fan-shaped hairs 0.024 to 0.05 mm. long on the abdomen; hairs on the vertex 0.056 to 0.065; antennæ 0.75 to 0.85; antennal III, 0.14 to 0.19; IV, 0.10 to 0.12; V, 0.12; VI, 0.09 to 0.11 plus 0.16 to 0.18; rostrum surpassing second coaxae; rostral IV plus V needle-like, 0.1 to 0.12; tibial hairs flattened to slightly fan-shaped on the outer side and 0.024 to 0.038 mm. long; on the inner side pointed and 0.023 to 0.031; hind tibiæ 0.5 to 0.56; hind tarsi 0.1 to 0.11; cornicles pale, 0.42 to 0.47; cauda 0.125 to 0.15 mm. long.

Taxonomy.—*P. zavillis* differs from *P. tridentatae*, *P. essigi* and *P. glauca* in having hairs more numerous and much more fan-shaped; and in having the outer tibial hairs flatter. *P. zavillis* differs from *P. xenotrichis* in having base

of antennal VI shorter than antennal IV; antennal IV longer than the hind tarsi; rostral IV plus V shorter than the cauda; and in not having the VIII abdominal segment superimposed on the cauda.

Collections.—On *Artemisia tridentata* at Jackson Hole, Wyoming, June 12, 1936 (Crystle K. Smith: C. F. Smith).

Type in the collection of the senior author.



Pseudoepameibaphis tridentatae (Wilson). Alate, A–C; apterous, D–H; E, body hairs. *P. essigi*, n. sp., apterous, I–M; L, body hairs. *P. glauca*, apterous, N–P, T; alate, Q–S. *P. xenotrichis* n. sp., apterous, U–Y; U, body hairs. *P. zavillis* n. sp., apterous, Z–DD; CC, body hairs.

THEOPHRASTUS OF ERESOS AS AN ECONOMIC ENTOMOLOGIST

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University of Washington, Seattle, Washington

Science is organized knowledge. This is platitudinous, but it is frequently forgotten by the science historian, who drapes the most isolated and inconsequential observations as science. Thus, multitudes of persons at every stage of human culture have noted some of the facts of insect injury, but it is only when these observations become organized that we can speak of economic entomology. It is interesting, therefore, to note the occurrence of such organized observations in the scientific literature of ancient Greece.

Theophrastus was born at Eresos on the island of Lesbos between 373 and 368 B.C. There is ancient authority (Diog. L. v. 36) for the supposition that he joined Aristotle at Athens before the death of Plato in 346/7, but Jaeger (Aristotle, Eng. Trans. 1934, pp. 115–116) suggests that he did not meet the Stagerite until he opened a school of philosophy at Assos (348–345) on the coast of Asia Minor, only a few miles distant from Lesbos. Here, at any rate, and in nearby Mitylene, he was associated with Aristotle during those momentous years when the science of zoology was taking form in Aristotle's mind. He may well have been the ''research assistant'' in some of those studies and have shared the fate of many another research assistant—that of doing much of the work and receiving none of the credit.

Thenceforth Theophrastus was associated with Aristotle during the rest of Aristotle's life, at first in Macedonia at the court of King Philip, and then at Athens; and after Aristotle's death in 322, he became head of his school, surviving until the 123rd Olympiad (288–285). Personally he was of a retiring, studious disposition, entirely devoted to his philosophical and scientific studies; and he must have been much relieved when the turn of events made it unnecessary for him to marry Aristotle's daughter, Pythias, as Aristotle's will directed. In fact, he never married,

and his philosophical justification of celibacy is contained in a fragment that is still preserved (Zeller, *Aristotle* ii, p. 405).

With the passage of the centuries, Theophrastus became known principally as the author of a work, *Ethical Characters*—brief, vigorous and trenchant delineations of moral types,—and as the "father of botany." This was the result, in great measure, of the unkind fashion in which the years treated Theophrastus' literary legacy. For, in reality, he seems to have carried on studies along the same broad lines as his master, Aristotle, seeking, principally, to polish up and fill out the details of the latter's system. Indeed, the extant treatises on plants may be looked upon as an elaboration of Aristotle's account that was so successful as to completely displace the latter, which became lost after the time of Hermippus of Smyrna, about 200 B.C.[1]

The account of plants given by Theophrastus is the most complete botanical work of ancient or mediaeval time. Not only does he mention 550 kinds of plants, but, in the *Enquiry into Plants,* he treats them from many different points of view, so that mention of the insect enemies of certain plants is introduced as integral portions of the larger work. The references are not extensive, but they represent the effort at organizing observations that is the basis of all scientific work.

Thus, in Book VII, chapter V, on "pot-herbs," he says:

"As for pests,—radish is attacked by fleas,[2] cabbage by caterpillars and grubs, while in lettuce, leek, and many other herbs occur 'leek-cutters.' These are destroyed by collecting green fodder, or when they have been caught somewhere in a mass of dung, the pest being fond of dung emerges, and having entered the heap, remains dormant there; wherefore it is then easy to catch, which otherwise it is not. To protect radishes against fleas it is of use to sow vetch among the crop; to prevent the fleas from being engendered they say that there is no specific."

And again, book VIII, chapter X:

"Wheat is . . . destroyed by grubs; sometimes they eat the

[1] See Zeller, *Aristotle* i, pp. 93–94.

[2] Hort (p. 95) translates ψυλλα, "spider," and Bodenheimer (p. 72), "Erd-Flöhe," but there appears no good reason for departing from a literal rendering, especially since Bodenheimer (l.c.) suggests that the insect in question is *Phyllotreta cruciferarum* Goeze, one of the "flea-beetles."

roots, as soon as they appear, sometimes they do their work when by reason of drought the ear cannot be formed; for at such times the grub is engendered, and eats the haulm as it is becoming unrolled; it eats right up to the ear and then, having consumed it, perishes. And, if it has entirely eaten it, the wheat itself perishes; if however it has only eaten one side of the haulm and the plant has succeeded in forming the ear, half the ear withers away, but the other half remains sound. However it is not everywhere that the wheat is so affected; for instance this does not occur in Thessaly, but only in certain regions, as in Libya and at Lelanton in Euboea.

''Grubs also occur in *okhros, lathyros* and peas, whenever these crops get too much rain and then hot weather supervenes; and caterpillars occur in chick-peas under the same conditions. All these pests perish, when they have exhausted their food, whether the fruit in which they occur be green or dry, just as wood-worms do and the grubs found in beans and other plants, as was said of the pests found in growing trees, and in felled timber. But the creature called 'horned-worm' is an exception. Now in regard to all these pests the position makes a great difference, as might be expected. For the climate, it need hardly be said, makes a difference according as it is hot or cold, moist or dry; and it was the climate which gave rise to these pests; wherefore they are not always found even in places in which they ordinarily occur.''

Later on (VIII. xi) the engendering of grubs (pea-weevils) by seeds as they decay is noted, for Theophrastus, as we have seen, was perfectly ready to accept abiogenesis as a fact, whenever the observations seemed to point that way.

Book IV, chapter XIV is a six or seven page discussion of the diseases of trees; worms are mentioned several times:

''Of the worms found in fig-trees some have their origin in the tree, some are produced in it by the creature called the 'horned-worm'; but they all turn into the 'horned-worm'; and they make a shrill noise. . . . In Miletus the vines at the time of flowering are eaten by caterpillars, some of which devour the flowers, others, a different kind, the leaves; and they strip the tree; these appear if there is a south wind and sunny weather. . . .

"There is a . . . disease incident to the olive, which is called cobweb; for this forms on the tree and destroys the fruit. . . . And the fruits of some get worm-eaten, as olive, pear, apple, medlar, pomegranate. Now the worm which infests the olive, if it appears below the skin, destroys the fruit; but if it devours the stone it is beneficial. And it is prevented from appearing under the skin if there is rain after the rising of Arcturus. Worms also occur in the fruit which ripens on the tree, and these are more harmful as affecting the yield of oil. Indeed these worms seem to be altogether rotten; wherefore they appear when there is a south wind and particularly in damp places. . . ."

Book V, chapter IV treats of wood:

"They say that the wood of the fir is more liable to be eaten by the *teredo* than that of the silver-fir; for that the latter is dry, while the fir has a sweet taste, and that this is more so, the more the wood is soaked with resin; they go on to say that all woods are eaten by the *teredo* except the olive, wild or cultivated, and that these woods escape, because of their bitter taste. Now woods which decay in sea-water are eaten by the *teredo,* those which decay on land by the *skolex* and *thrips;* for the *teredo* does not occur except in the sea. It is a creature small in size, but has a large head and teeth; the *thrips* resembles the *skolex,* and these creatures gradually bore through timber. The harm that these do is easy to remedy; for, if the wood is smeared with pitch, it does not let in water when it is dragged down into the sea; but the harm done by the *teredo* cannot be undone. Of the *skolekes* which occur in wood, some come from the decay of the wood itself, some from other *skolekes* which engender therein. For these produce their young in timber, as the worm called the 'horned-worm' does in trees, having bored and scooped out a sort of mouse-hole by turning round and round. But it avoids wood which has a strong smell or is bitter or hard, such as boxwood, since it is unable to bore through it. . . ."

Finally, the role of the *psenes* or 'gall-insects' in the caprification of figs is noted (II. viii). Insect galls are likewise referred to (III. v and vii), but there is no evidence that Theophrastus appreciated that they were the product of animal activity.

Such is the evidence, then, that Theophrastus must be reckoned among the earliest exponents of economic entomology.

I have not ventured to interrupt the quotations with attempts at the identification of the insects mentioned, nor is their recognition necessary for the purpose of the present note. But the identity of many of the species is not difficult to trace. The fleas on radish were flea-beetles; the caterpillars on cabbage were cabbage butterflies; the 'horned-worm,' a cerambycid beetle; the grubs engendered in seeds, pea-weevils; the cobweb of olive, red spider; the worm of fruits, codling-moth; the *teredo* of timber in sea-water, the ship worm. Bodenheimer in his *Geschichte der Entomologie* proposes additional identifications still.

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PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

Meeting of October 5, 1937

As previously announced there was no formal meeting. Members and guests indulged in informal discussions. Refreshments were served.

Lucy W. Clausen, *Secretary.*

Meeting of October 19, 1937

A regular meeting of the New York Entomological Society was held in in the Roosevel Memorial on October 19, 1937; President Curran in the chair with forty-three members and visitors present.

Mr. Raoul Nadeau was elected to active membership.

The program committee announced that at the November 16 meeting Dr. E. P. Darlington would speak on ''The Biology of Cranberry Culture.''

The meeting was given over to the entomological experiences of members during the summer. Mr. William T. Davis exhibited a family of *Panchlora cubensis* which he had kept for over a year. Dr. Payne told of grasshoppers girdling trees in the middle west.

We were once again honored by a visit from Dr. Arthur Gibson, who displayed some slides of the Laboratory at Belleville, Ontario.

Most of the members present contributed to the evening's general discussion.

Lucy W. Clausen, *Secretary.*

Meeting of November 16, 1937

A regular meeting of the New York Entomological Society was held in Roosevelt Memorial on November 16, 1937; President Curran in the chair with forty-seven members and visitors present.

The program committee announced that at the next meeting Dr. A. L. Melander would speak on ''Who's Who Among the Insects of 1937,'' illustrated with colored motion pictures.

Dr. Klots proposed Dr. A. Glenn Richards for active membership. By suspension of the by-laws Dr. Richards was elected immediately.

Mr. Robert Trout gave a very interesting survey of the biology of Zoraptera.

Dr. E. P. Darlington, the speaker of the evening spoke on ''Blueberry and Cranberry Culture'' and his abstract follows.

Byrley F. Driggers, while working at the White properties in New Lisbon, N. J., was first to describe the life history of the coleopterous stem-borer, *Oberea myops*. The only control for this insect is to pinch off the wilted shoots well below the circular row of egg punctures otherwise the larvæ bore down the cane into the root of the plant. Driggers also discovered that five species of flies were responsible for the blueberry gall, the most common being

Hermadas nubilipennis Ashmead. In 1920 and 1921 I worked on the life history of the blueberry tipworm *Contarinia vaccinii* Felt and furnished material for identification of this species which is Type A 3207 in the N. Y. State Museum.

Gelechia trialbamaculella Chambers, a leaf feeder, is common on both wild and cultivated blueberries.

Some years the fall webworm is quite numerous but it feeds in colonies and the nests are quite noticeable.

Of the *Datanas, drexelii* is the most common and as it also feeds in clusters it may readily be detected and destroyed.

The flannel moth *Lagoa crispata* often prefers tender leaves of blueberry to coarser leaves of oak.

In bulletin No. 275 of U. S. Dept. of Agric., Feb., 1932, F. H. Lathrop and C. B. Nickels review the work of previous years and give a detailed account of the biology and control of the blueberry maggot in Washington County, Maine.

In Maine, where all the berries go to the cannery, an arsenic dust may be used for control but in New Jersey this is not practical as all our berries are sold on the fresh fruit-market. Application of rotenone dust is made three times during the season by airplane or autogiro, early in the morning before the sun has risen enough to cause a breeze.

Rhagoletis mendax and *R. pomonella* are similar from egg to adult fly although separated as two species.

There are three, and probably more, blueberry fruit worms. Most common is the so-called cranberry fruit-worm *Mineola vacinii. Moodna ostrinella* Clemens is also a fruit worm on blueberries.

Laspeyresia packardii Zeller has been reared from blueberry fruit.

Pollination.—The blueberry is practically sterile to its own pollen so that it is necessary to have at least two distinctly related varieties in proximity to insure a good set of fruit. Bumblebees are better as pollenizers than honey-bees because of their longer tongues. The bumblebee just punctures the corolla and goes after the nectar.

Cranberries.

As early as 1850 some citizens of Medford, N. J., tried to develop the natural cranberry bog with the idea of improving the yield. All varieties produced today are but natural hybrids, originating in some patch of wild berries or from seeds in some commercial bog of mixed varieties.

On July 19, 1915, Harold B. Scammel, of the U. S. Department of Agriculture, published his paper on ''The Cranberry Root Worm'' (*Rhabdopterus picipes* Oliv.). On September 21, 1917, he published the result of his 4 years study of the cranberry girdler *Cranbus hortuellus.*

Cranberry fireworms.—Most common is the black headed *Rhopobato vacciniana* Packard. Next in importance is the cranberry yellow head, *Peronea minuta.*

In 1926 it was proven that the blunt nosed leaf hopper *Euscelis striatulus* transmitted disease.

Lucy W. Clausen, *Secretary.*

Meeting of December 7, 1937

A regular meeting of the New York Entomological Society was held in Roosevelt Memorial on December 7, 1937; President Curran in the chair, with one hundred and thirty members and visitors present.

The program committee reported that Dr. William Sargent would exhibit paintings of Odonata at the December 21 meeting. Members were invited to add to the round-table discussion.

The resignation of Mrs. M. P. Comstock was accepted with regret.

A letter sent to Dr. Curran concerning the resolution of the American Association of Economic Entomologists to promote a closer bond between all branches of entomology was referred to the Executive Committee.

Dr. A. L. Melander, the speaker of the evening, then showed the Society colored motion pictures of insects going about their daily business.

LUCY W. CLAUSEN, *Secretary.*

MEETING OF DECEMBER 21, 1937

A regular meeting of the New York Entomological Society was held in Roosevelt Memorial on December 14, 1937; President Curran in the chair, with forty visitors and members present.

At the next meeting of the Society the annual election of officers was scheduled. Dr. Curran appointed Mr. J. D. Sherman, Mr. E. L. Bell, and Dr. A. L. Melander to act as nominating committee.

Mr. Mutchler proposed for active membership Mr. Edwin W. Teale, 93 Park Ave., Baldwin, L. I., and Miss Lillian L. Davis, of Studio Club, 210 E. 77th Street, New York City.

Dr. William Sargent exhibited his paintings of Odonata and spoke upon some of the habits of dragon flies.

Dr. Herbert Ruckes spoke on the genus *Brochymena* upon which he is working.

LUCY W. CLAUSEN, *Secretary.*

MEETING OF JANUARY 4, 1938

The annual meeting of the New York Entomological Society was held on January 4, 1938, in Roosevelt Memorial; President Curran in the chair with twenty-eight visitors and members present.

The report of the nominating committee was read by Mr. E. L. Bell. The secretary was empowered to cast one ballot for the election of new officers, as follows:

President—Dr. William Moore
Vice-President—Dr. H. T. Spieth
Secretary—Lucy W. Clausen
Treasurer—Paul T. Richard
Librarian—Frank E. Watson
Curator—Andrew J. Mutchler
Executive Committee—William T. Davis
Dr. F. E. Lutz
Dr. William Proctor
Herbert F. Schwarz
Henry Bird
Publication Committee—Harry B. Weiss
Dr. C. H. Curran
John D. Sherman
Ernest L. Bell

Dr. Moore, the newly elected president, presided during the balance of the meeting.

Dr. Curran proposed a vote of thanks to the treasurer and secretary for the work they have done and for their interest in the Society.

Mr. H. F. Schwarz made a motion to thank the retiring president. These motions were adopted.

At the next meeting Mr. H. Dietrich of Cornell University will give an illustrated talk on "The Dutch Elm Disease."

Dr. Moore appointed as program committee Dr. Herbert Ruckes, Mr. Frank Soraci, and Dr. C. H. Curran.

LUCY W. CLAUSEN, *Secretary.*

MEETING OF JANUARY 18, 1938

A regular meeting of the New York Entomological Society was held on January 18, 1938, in Roosevelt Memorial; President Moore in the chair with forty-two members and visitors present.

Due to the absence of the secretary Mr. Kisliuk was appointed temporary secretary.

The program committee announced that on February 1 there would be a general discussion of notes by members led by Dr. H. T. Spieth.

Mr. J. C. Crawford was proposed for active membership by Mr. Kisliuk. A motion made by Dr. Horsfall to suspend the usual procedure and admit Mr. Crawford to immediate membership was adopted.

The speaker of the evening, Mr. Dietrich, then talked on "The Dutch Elm Disease." At the close of Mr. Dietrich's talk there was a general discussion.

The chairman announced the death in London of Major Ernest Austin. Major Austin was connected with the British Museum for a long time, having done considerable work with the tsetse fly as well as with other phases of general medical entomology.

ABSTRACTS OF TALK BY MR. H. DIETRICH

The name "Dutch Elm" disease is used because the disease was first reported from Holland in 1919. In 1922 Schwarz associated a fungus, *Graphium ulmi* with the dying of elms. The disease now occurs over about 1638 square miles in the New York metropolitan area. In this area over 27,000 elms affected with the disease have been destroyed.

How did the disease organism get to this country? Elm burl logs were being imported from Europe to be used for veneer. These logs were found to have both the fungus and the insect vectors. The logs entered at the ports of New York, Baltimore, Norfolk and New Orleans and were shipped to Chicago, Kansas City, Montana, Indianapolis, Cincinnati.

When *Graphium ulmi* gains entrance to the live part of an elm, the fungus seems to stop up the water tubes, although it may have a toxic effect. As a result the leaves droop and eventually turn brown and dry up. If one cuts into a diseased branch a brownish discoloration will be noted. This brown growth has to be cultured on agar plates to definitely identify the fungus. The fungus produces, in sheltered places such as insect galleries and pupal cells, fruiting bodies called coremia. Hence insects emerging from these pupal cells are likely to be covered with spores of *Graphium ulmi.*

In Europe two species of bark-beetles *Scolytus scolytus* and *Scolytus multi-*

striatus have been found to breed commonly in dead or dying elms. Fortunately only *S. multristriatus* has gained a foothold in this country.

Many other insects were reared from elm wood. Since *S. multristriatus,* however is the only elm insect known to feed regularly on the small branches it is generally accepted as the main vector of the Dutch Elm disease. In close stands of elm the fungus may go from one elm to another through root grafts.

Control

In this country all infected trees are immediately destroyed and the stumps killed. The major infected area is within 50 miles of New York City. The total number of diseased trees found in the following states during 1937 gives some idea of the magnitude of the work: New York, 1264; New Jersey, 4426; Connecticut, 113. The best control recommendations are still the same as are given in Cornell Extension Bulletin No. 290, June 1934, namely sanitation, cutting out of all dead elm wood fertilization and watering of all trees to make them more vigorous.

Max. Kisliuk, *Sec. pro tem.*

Meeting of February 1, 1938

A regular meeting of the New York Entomological Society was held on February 1, 1938, in Roosevelt Memorial; President Moore in the chair with thirty members and visitors present.

The program committee reported that Dr. John B. Schmitt of Rutgers University would speak at the next meeting on the ''Feeding Mechanism of Moths and Butterflies.''

There were two proposals for active membership—Dr. John B. Schmitt, Rutgers University, New Brunswick, New Jersey and Mr. William H. Bennett, State College of Forestry, Syracuse University, New York.

The meeting was then given over to a discussion of notes by members.

Lucy W. Clausen, *Secretary.*

Meeting of February 15, 1938

A regular meeting of the New York Entomological Society was held on February 15, 1938 in Roosevelt Memorial; President Moore in the chair with fifty visitors and members present.

The program committee announced that Messrs. Bruce and Sheridan Fahnestock would speak at the next meeting.

There were two elections to active membership—Dr. John B. Schmitt and Mr. William Bennett.

Mr. Robert Rosenbaum, 340 W. 86th Street, New York City was proposed for active membership.

The speaker of the evening Dr. John B. Schmitt then spoke on ''The Feeding Mechanism of Moths and Butterflies.''

Summary of Dr. Schmitt's Talk:

1. The coiled proboscis of Lepidoptera is entended by means of blood pressure created in the stipes of each maxilla. This pressure is caused by three pairs of muscles, which by their contraction press the stipes against the head wall. Two pairs of these muscles arise on the anterior arms of the tentorium and the third pair arises on the gena.

2. The sucking pump is a compound organ derived from the pharynx, the buccal cavity, and the cibarium. This is evidenced by these facts: (1) true pharyngeal dilators are inserted only in the posterior part of the pump; (2) muscles homologous with the compressors of the labrum are present in some Lepidoptera; and (3) the dorsal salivarium muscles arise on the pump floor, showing that the hypopharynx forms at least the anterior part of the floor.

3. There is no labial musculature except that of the palpi. There are generally two pairs of palpus muscles, but in many families only one pair, or none at all, may be found.

4. The area posterior to the labial palpi is bounded by the hypostoma, the hypostomal ridge offering an insertion for the ventral segmental muscles. A hypostomal bridge is sometimes present.

5. The anterior arms of the tentorium are well developed but lack dorsal arms. The posterior tentorial bridge is short and weak. The great length of the hypostoma in Lepidoptera elevates the tentorium to a higher position in the head, with respect to other cephalic structures, than is common.

6. The antennal muscles arise on the anterior arms of the tentorium and vary in number from one to five pairs. They are always well developed, sometimes at the expense of other head structures and, in moths with obsolete feeding structures, are often the only functional muscles within the head.

LUCY W. CLAUSEN, *Secretary.*

CORRECTION

Volume XLV, p. 409: The reference to Professor Brunner should have been to Prof. Lawrence Bruner, who died in Berkeley, California, January 30, 1937.

The
New York Entomological Society

Organized June 29, 1892—Incorporated June 7, 1893

Certificate of Incorporation expires June 7, 1943

The meetings of the Society are held on the first and third Tuesday of each month (except June, July, August and September) at 8 P. M., in the AMERICAN MUSEUM OF NATURAL HISTORY, 77th Street and Columbus Avenue.

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SEPTEMBER, 1938

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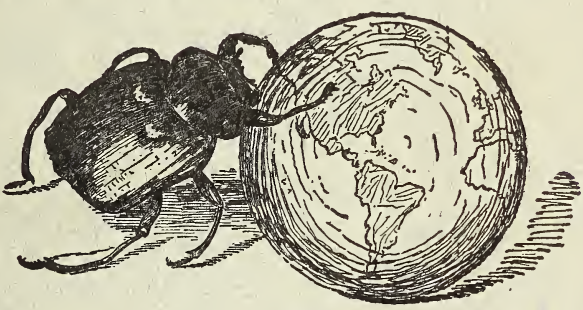

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VOL. XLVI SEPTEMBER, 1938 No. 3

THE GENUS ATYMNA STÅL AND A NEW RELATED GENUS (HOMOPTERA: MEMBRACIDÆ)[1]

BY C. C. PLUMMER

ASSOCIATE ENTOMOLOGIST, DIVISION OF FRUIT FLY INVESTIGATIONS, BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE, UNITED STATES DEPARTMENT OF AGRICULTURE

In 1867 *Atymna* was described as a subgenus of *Cyrtosia* Fitch (nom. nov. *Cyrtolobus* Goding (1892)) by Carolus Stål. Stål cited *Smilia castaneæ* Fitch in his description so that species has become, *ipso facto,* the type species. The group *Atymna* remained a subgenus until it was given generic rank in Funkhouser's catalogue.[2] In the present paper the genus has been redescribed, two new species from Mexico have been added, one species transferred to *Cyrtolobus,* and a new closely-related genus described.

Atymna Stål

1867. Stål, C. Bidrag till Hemipterernas Systematik. Ofversigt af Kongl. Vetenskaps-Akademiens Förhandlingar, xxiv: 554.

"b. Thorace anterius altissimo, dorso etiam inter et ante angulos laterales paullo compresso-acuto vel altius carinato.—Subg. *Atymna* Stål. (Ad hoc

[1] The author wishes to acknowledge the kindness of Dr. W. D. Funkhouser in loaning specimens of all species of *Atymna* found in the United States. The types of the new species described in this paper are to be deposited in the collection of the U. S. National Museum as soon as possible.

[2] Funkhouser, W. D. 1927. General Catalogue of the Hemiptera. Fasc. 1, Membracidae, 581 pp. Smith College, Northampton, Mass.

subgenus pertinent *Smilia castaneæ* Fitch, verisimiliter etiam plures species ab auctoribus americanis ad *Smiliam* et *Gargarum* relatæ).''

Redescription of Genus

Crest of pronotum rounded in front, usually high, highest above humeral angles or humeral sinuses behind angles; metopidium straight, nearly straight, or convex, but in all specimens the crest rounded above humeral angles and sinuses. Behind the humeral sinuses the crest straight to posterior end of pronotum, rounded to posterior third and then straight to terminal end, or straight with a sinus at posterior third and then straight or slightly convex to terminal end of pronotum. Sides of pronotum tectiform, not compressed at median spot. Scutellum concealed, tibiæ not dilated, posterior tarsi not reduced, tegmina membranous, partly concealed by pronotum, third apical cell stylate, venation as in *Cyrtolobus.*

Type: *Atymna castaneæ* Fitch.

This genus is very close to *Cyrtolobus,* falling between that genus and *Smilia* Germar. *Atymna* can be distinguished from *Cyrtolobus* by the crest being highest above the humeral angles or humeral sinuses and by the rectilinear or nearly rectilinear slope of the dorsum to the terminal end of the pronotum. The crest of *Cyrtolobus* is more regularly arcuated, with the highest point at the middle or close to the middle. *Atymnina,* n. gen., is recognized by the very low dorsal crest being almost straight to the middle, where it gradually decurves to the terminal end of the pronotum.

The genus *Atymna* has been broadly defined to include such divergent forms as *A. inornata* Say and *A. querci* Fitch, each with a rather low dorsal crest in front, convex metopidium, and straight dorsal line behind the humeral angles, and others such as *A. gigantea,* n. sp., with a very high crest in front, straight metopidium, and broken dorsal line behind the middle. *A. inornata, A. querci,* and *A. pilosa* Funkhouser seem to form a natural group and might well be placed in a separate genus, but this does not appear advisable or necessary at the present time. The writer concurs with Dr. Funkhouser that *Cyrtolobus* (*Atymna*) *helena* Woodruff is not a true *Atymna* and should not be included

in that genus. The highest point of the crest of *C. helena* is behind the humeral sinuses, not above them, in the 7 specimens examined by the author. Furthermore, the crest or dorsal line of the pronotum is convex, not straight, to the posterior termination of the pronotum.

Fortunately, all except one of the previously known species in this genus have been well described or redescribed by Van Duzee and Funkhouser. These references are in Funkhouser's catalogue[3] and need not be repeated here. The remaining species, *A. atromarginata*, was recently described by Goding.[4] A side-view drawing of *A. simplex* V. D. (Pl. VIII, Fig. 1), and front-view drawings of *A. castaneæ* (Pl. VIII, Fig. 2) and *A. querci* (Pl. VIII, Fig. 3) are included to assist in the recognition of those species.

KEY TO THE GENUS *Atymna* (FEMALES)

I. (II) Pronotum high. (Pl. VIII, Figs. 1, 2, 6–8. Funkhouser,[5] Pl. xxviii, Fig. 11.)
- A. Humeral angles prominent, auriculate. Pronotum sharply rounded at summit, then sloping straight to posterior end. Length 8.0 mm.; width 3.5 mm. (Ecuador). *atromarginata* Goding[6]
- B. Humeral angles not prominent, not auriculate. Crest of pronotum more evenly rounded at summit.
  - 1. (2) Pronotum arcuate to terminal third, thence straight to posterior end. Very large, length 10.5 mm.; width 4.0 mm. (Mexico) .... *gigantea* n. sp. (Pl. VIII, Figs. 4–6.)
  - 2. (3) Crest of pronotum behind humeral sinuses straight to posterior end. Length 7.5 to 8.0 mm.; width 2.5 to 2.75 mm. (Eastern U. S. A.) .... *castaneae* Fitch (Funkh.,[5] Pl. xxviii, Fig. 11.)
  - 3. (2) Crest of pronotum straight from behind humeral sinuses with usually a slight sinuation behind middle.
    - a. Metopidium sloping. Inferior margins of face rounded. Length 5.75 to 6.0 mm.; width 2.0 to 2.25 mm. (Mexico) .... *distincta*, n. sp. (Pl. VIII, Figs. 7–10.)

[3] Loc. cit.

[4] Goding, F. W. 1928. New Membracidae VII. Bull. Brook. Ent. Soc. 23: 137–142. 1929. The Membracidæ of South America and the Antilles. IV. Subfamilies Hoplophorioninæ, Darninæ, Smiliinæ, Tragopinæ. (Homoptera.) Amer. Ent. Soc. Trans. 55: 197–330, illus. (Key).

b. Metopidium convex. Inferior margins of face straight. Length 8.0 to 8.25 mm.; width 3.0 (Southwestern U. S. A.) .... *simplex* V. D. (Pl. VIII, Fig. 1.)

II. (I) Pronotum low, metopidium convex. (Pl. VIII, Fig. 3. Funkh.,[5] Pl. xxviii, Figs. 13–14.)

A. Pronotum densely pilose; humeral angles prominent, auriculate. Length 4.8 mm.; width 2.0 mm. (Peru) .... *pilosa* Funkhouser[6]

B. Pronotum not pilose; humeral angles not prominent, not auriculate.

1. (2) Head smooth with very fine shallow punctuations. Both sexes green. Length 6.0 mm.; width 2.0 mm. (Eastern U. S. A.) .... *inornata* Say (Funkh.,[5] Pl. xxviii, Fig. 14.)

2. (1) Head usually sculptured and with few, if any, punctations. Females green; males brown. Length 6.0 to 6.5 mm.; width 2.5 mm. (Eastern and midwestern U. S. A.) .... *querci* Fitch (Pl. VIII, Fig. 3 Funkh.,[5] Pl. xxviii, Fig. 13.)

Atymna gigantea new species (Pl. VIII, Figs. 4–6)

FEMALE: Green, largest in genus (10.5 mm. long). Crest of protonum high in front, rounded to posterior third, thence straight to posterior end of pronotum. Shape of pronotum superficially resembling that of *Smilia camelus* Fab.

Head with base straight at middle, at each end base rounded down to eyes, more than twice as wide as long; coarsely and irregularly punctate, not sculptured, with very few hairs; ocelli large, prominent, nearer to each other than to the eyes, and below an imaginary line drawn through center of the eyes; epicranial suture deep; inferior margins of face slightly sinuate; clypeus deflexed, narrowed below inferior margins of face.

Pronotum high, highest just behind humeral angles; metopidium straight; crest well rounded to posterior third, thence straight to acute posterior termination of pronotum; lateral margins very straight, terminal end extending past middle of terminal areoles of tegmina; humeral angles obtuse, rounded, not prominent; pronotum evenly and coarsely punctuate.

Color of head testaceous, maculate with gray between the eyes. Pronotum green when collected, now green maculate with testaceous; mid-carina reddish brown except in front, where it is light testaceous marked with brown, brown in some punctations on sides below carina. Tegmina hyaline, clouded with brown at apices; veins light testaceous. Body and legs testaceous, the tarsi and claws dark reddish brown. Dark brown area at base of ovipositor.

[5] Funkhouser, W. D. 1917. Biology of the Membracidae of the Cayuga Basin. Cornell Univ. Agr. Exp. Sta. Mem. 11, pp. 173–445, illus.

[6] Not seen by author.

Male: Smaller (9.0 mm.); clypeus more constricted below inferior margins of face than in female. Pronotum lower, sides more regularly tectiform; crest of pronotum rounded in front and straighter from behind humeral angles to posterior termination than in female, a sinus at posterior third; lateral margin curved upward to apex of pronotum; apex acute, not attaining terminal areoles of tegmina.

Head testaceous, maculate with brown. Pronotum green when collected, now testaceous maculate with green. Tegmina hyaline, the apical portion entirely brown; veins dark brown. Thorax light testaceous marked with black, the third tarsus and claws dark brown. Abdomen black, venter maculate with light testaceous. In other respects similar to the female.

Type, female, el Desierto de los Leones, Distrito Federal, Mexico (9,000 feet), September 2, 1934.

Allotype, male, from same place, June 17, 1934.

Described from single male and female taken on oak (*Quercus* sp.). Although these specimens were taken on the same tree on different dates there is no question that they are the same species. It is evidently very scarce.

Atymna distincta new species (Pl. VIII, Figs. 7–10)

Female: Small, bright green species with pronotum high in front. Close to *A. gigantea,* n. sp., but distinguished from that species by size, coarser punctations, and rounded inferior margins of face. Length 5.75 to 6.0 mm.; width 2.0 to 2.25 mm.

Head with base arcuate, twice as wide as long; numerous and even punctations, very few hairs; ocelli small, nearer to the eyes than to each other, below an imaginary line drawn through the center of the eyes; clypeal margins of the face rounded and indistinct; epicranial suture indistinct; clypeus projecting only a short distance below inferior margins of face; inferior margins of face rounded, not typical of genus.

Pronotum with metopidium straight or nearly straight; crest high and rounded above humeral angles and humeral sinuses, continuing as a straight line to posterior third, where there is usually a slight sinuation, thence slightly convex to posterior termination of pronotum; lateral margins almost straight or slightly arched to posterior apex; apex acute, almost as long as tegmina; humeral angles obtuse, rounded at apices, not prominent; deeply and coarsely punctate.

Color when collected bright green, now becoming light testaceous maculate with green. Head testaceous; eyes dark brownish red. Small amount of brown on dorsal carina. Thorax and abdomen light green to testaceous. Legs light testaceous, claws darker. Tegmina hyaline, apices sometimes marked with testaceous.

Male: Smaller than the female (5.0 mm.); brown and cream colored, the

markings somewhat resembling those of the male of *Cyrtolobus parvulus* Woodruff.

Pronotum lower than in female, crest evenly rounded from base of head to slight sinus in middle, after which the crest is rounded slightly in front of another, more prominent, sinus at posterior third of pronotum, thence rounded down to acute terminal end of pronotum; upper half of pronotum laterally compressed behind humeral angles, a bulbous expansion on side below crest in front of first sinus of crest, sometimes obscure; another smaller expansion below crest between the two sinuses of crest, sometimes absent; posterior end of pronotum not reaching middle of terminal areoles of tegmina.

Head cream colored, marked with brown. Eyes brown. An oblique cream-colored pronotal band extending from dorsum above humeral angle to middle of lateral margin, sometimes obscure or missing; pronotum in front of band brown, mottled with cream; behind the cream-colored vitta a light to dark brown V-shaped area extending from crest to lateral margin and surrounding a mid-dorsal translucent area; the front arm inclined forward and contiguous with the cream-colored vitta, the posterior arm inclined only slightly forward; the front arm of variable width, wider at extremities, the posterior arm wider and less variable. Posterior to this vitta a narrow, subapical cream-colored band, usually obscure at middle, followed by light to dark brown veins and light brown markings at apices. Under parts of body light testaceous. In other respects similar to the female.

Type, female, near Horno Viejo, Distrito Federal, Mexico (about 8,000 feet), July 11, 1934. This locality is at kilometer 17 on the road to Toluca, Mexico.

Allotype, male, same locality and date.

Described from 17 males and 46 females taken at type locality and at Santa Rosa, Distrito Federal, from May to September on oak trees (*Quercus* sp.). Two male and 4 female paratypes are in the collection of W. D. Funkhouser.

One of the tegmina of a female lacks the cross-vein at the base of the corium. This may suggest an affinity with the genus *Smilia*.

Atymnina new genus

Pronotum long and narrow; metopidium very low, convex; dorsal crest almost straight to middle, where it is gradually decurved to long narrow terminal end; lateral margin decurved to apex at posterior end; apex acute; sides of pronotum rounded in front above humeral angles and humeral sinuses, tectiform behind humeral sinuses. Scutellum concealed; tibiae not diliated, posterior tarsi not reduced; tegmina membranous, partly concealed by pronotum, third apical cell stylate, venation like that of *Cyrtolobus* and *Atymna*.

Type, *Atymnina elongata,* n. sp.

This genus falls close to *Atymna* but it can readily be distinguished by the low flat dorsum and by the long narrow appearance when viewed from the side.

Atymnina elongata new species (Pl. VIII, Figs. 11–12)

A green species with rather flat dorsum above humeral angles and long narrow pronotum. Length 7.5 mm.

Head with base straight, extreme margins sloping down to eyes; little more than twice as wide as long; a few coarse punctations, vaguely sculptured, sparsely pubescent; ocelli prominent, equidistant from each other and from the eyes, slightly below an imaginary line drawn through center of eyes; eyes large, prominent; inferior margins of face sinuate, less than half of clypeus extending below inferior margins of face.

Pronotum with metopidium convex; the cephalic half of dorsum flattened on top with crest straight, the flattened area being wider above humeral angles, from there to middle of dorsum becoming progressively narrower; crest behind middle convex to decurved posterior end of pronotum; apex acute, extending to middle of terminal areoles of tegmina; sides rounded to flattened dorsum of cephalic half, caudal half with sides tectiform; lateral margin decurved at extreme posterior end to apex; coarsely and evenly punctate, punctations smallest on metopodium.

Color green when collected; now light testaceous and green. Face, body, and legs testaceous maculate with green. Tegmina perfectly hyaline, veins marked with much green.

Type, female, Santa Rosa (about 8,000 feet), near el Desierto de los Leones, Distrito Federal, Mexico, September 3, 1934.

Described from a single female taken on oak (*Quercus* sp.). Since this genus is close to *Atymna* but easily distinguished from it, the writer feels justified in describing it from a single specimen at this time.

PLATE VIII

Figure 1. *Atymna simplex* V. D. Side view of female.
Figure 2. *Atymna castaneæ* Fitch. Front view of female.
Figure 3. *Atymna querci* Fitch. Front view of female.

Atymna gigantea, n. sp.

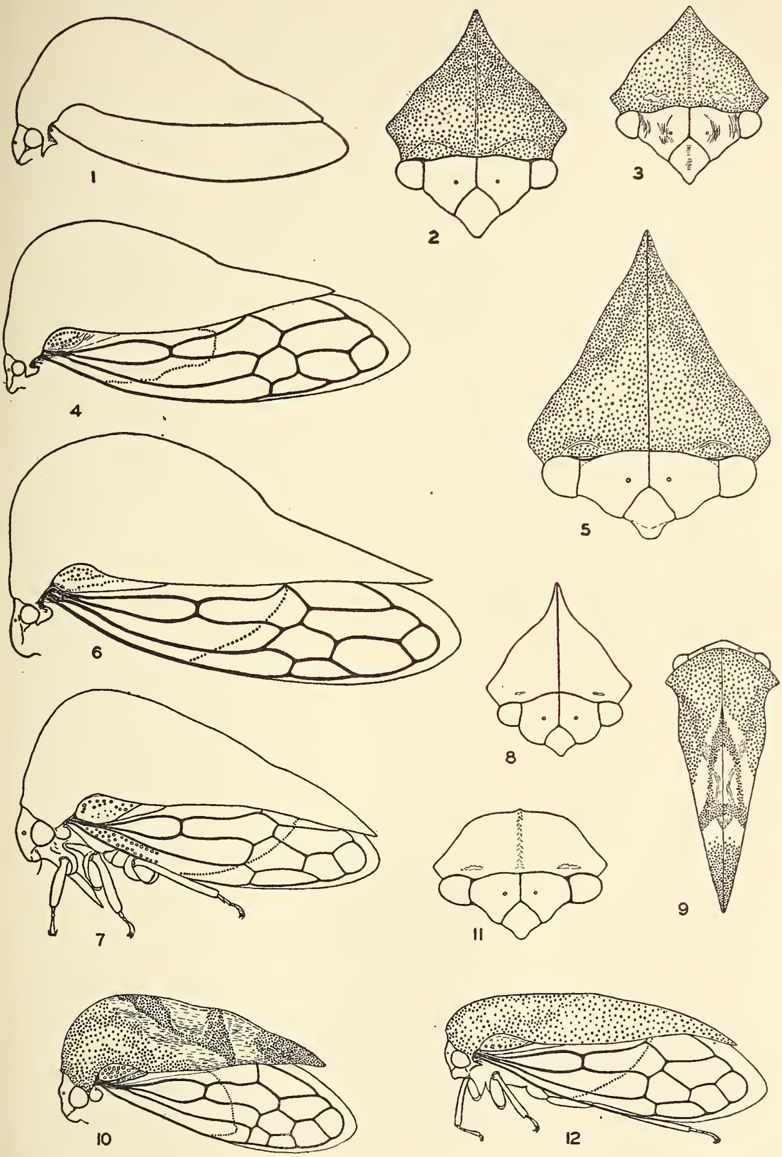
Figure 4. Side view of male.
Figure 5. Front view of female.
Figure 6. Side view of female.

Atymna distincta, n. sp.

Figure 7. Side view of female.
Figure 8. Front view of female.
Figure 9. Dorsal view of male.
Figure 10. Side view of male.

Atymnina elongata, n. sp.

Figure 11. Front view of female.
Figure 12. Side view of female.



MEMBRACIDÆ

PAPER FROM WASPS' NESTS

The social wasps and their paper nests are well known to entomologists, but few are aware that Jacob Christian Schäffer in his search for paper-making materials, actually made specimens of paper from wasps' nests. Schäffer who lived in Bavaria studied for the ministry, but natural history occupied his interest also and in 1765 he started a work on the subject of the possibilities of new paper-making materials, embodying the results of his experiments. More than anything else he was concerned with showing the enormous variety of materials that could be used for such a purpose. By observing the work of the social wasps Réamur and Schäffer thought of the idea of making paper from wood. Schäffer's six small volumes were published in Regensburg from 1765 to 1771 and his first volume includes specimens of paper made from wasps' nests, different kinds of wood, moss, and vines. Subsequent volumes included papers made from hemp, straw, cabbage stalks, bark, turf, cat-tail, corn husks, pine-cones, potatoes, leaves of various trees, etc.—H. B. W.

THE COMPARATIVE MORPHOLOGY OF THE MOUTHPARTS OF THE ORDER COLEOPTERA TREATED FROM THE STANDPOINT OF PHYLOGENY[1]

BY INEZ W. WILLIAMS

INTRODUCTION

With the exception of Stickney's monograph on the head capsule, Tanner's paper on the female genitalia, and Forbes' work on the wings, very little has been done on the comparative morphology of adult Coleoptera. Only a few scattered papers deal with the mouthparts of different species or with a single family at the most. The present studies of the labia and maxillæ of the representatives of most of the coleopterous families have been made with the purpose of supplementing Stickney's extensive and thorough work of the head capsules. It is hoped that these studies may add to the knowledge of the phylogenetic groupings of the families within the order.

The arrangement of the families in Leng's "Catalogue of Coleoptera of America north of Mexico" has been followed. A representative of each family has been chosen, more or less at random, for study. The consideration of members of the various subfamilies would undoubtedly have made comparisons much more complete, but due to the fact that suitable material was not available, the subfamilies have not been included. The Eucinetidæ, Nosodendridæ, Trogidae, and Byturidæ, which are treated by Leng (1920) as subfamilies, have not been considered in this paper. The Telegeusidæ, Micromalthidæ, Eurystethidæ, Plastoceridæ, Monoedidæ, and Brathinidæ have been omitted because they were either unobtainable or too minute to study with the equipment available.

As Stickney (1923) indicates in the case of the head capsule, attempts to arrange the figures of the labium and maxilla in a series from the generalized to the more specialized types proved unsuccessful. Primitive features of some structures are in many

[1] This paper is a portion of a thesis submitted to the faculty of the graduate school in partial fulfillment of the requirements for the degree of Ph.D. at Massachusetts State College, June, 1936.

cases combined with specialized features of other structures. For this reason, the figures of the one-hundred families involved in this paper have been arranged as nearly as possible in the family groupings presented by Leng in the "Catalogue of the Coleoptera."

ACKNOWLEDGMENTS

The investigations included in this paper were conducted under the supervision of Dr. G. C. Crampton. To him, the writer wishes to express sincere thanks for his invaluable advice and considerate criticism in the preparation of the figures and the manuscript, and also for specimens of some of the rarer families figured. The writer is deeply indebted to Dr. C. P. Alexander, not only for his helpful suggestions and criticisms of the plates and manuscript, but for furnishing many of the specimens used in this study. The writer also wishes to thank Mr. C. A. Frost for several species of beetles included in this paper.

COLEOPTERA

SUBORDER ADEPHAGA

CARABOIDEA

1. Cicindelidæ—*Cicindela sexguttata* Fab. (Fig. 1)
2. Carabidæ—*Harpalus caliginosus* (Fab.) (Fig. 2)
3. Amphizoidæ—*Amphizoa isolens* Lec. (Fig. 6)
4. Omophronidæ—*Omophron americanum* Dej. (Fig. 3)
5. Haliplidæ—*Laccophilus maculosus* (Germ.) (Fig. 4)
6. Dytiscidæ—*Colymbetes sculptilis* Harr. (Fig. 5)

GYRINOIDEA

7. Gyrinidæ—*Dineutes vittatus* (Germ.) (Fig. 7)
8. Paussidæ—*Paussus hova* (Fig. 8)

SUBORDER POLYPHAGA

HYDROPHILOIDEA

9. Hydrophilidæ—*Tropisternus glaber* (Hbst.) (Fig. 9)

SILPHOIDEA

10. Platypsyllidæ—*Platypsyllus castoris* Rits. (Fig. 10)
11. Leptinidæ—*Leptinus testaceus* Müll. (Fig. 11)

12. Silphidæ—*Silpha americana* L. (Fig. 13)
13. Clambidæ—*Clambus punctulum* Beck. (Fig. 12)
14. Scydmaenidæ—*Euconnus similis* Blatch. (Fig. 14)
15. Orthoperidæ—*Orthoperus brunnipes* Gyll. (Fig. 15)

STAPHYLINOIDEA

16. Staphylinidæ—*Staphylinus vulpinus* Nordm. (Fig. 16)
17. Pselaphidæ—*Pselaphus dresdensis* Hbst. (Fig. 17)
18. Clavigeridæ—*Claviger testaceus* (Fig. 19)
19. Ptilidæ—*Trichopteryx lata* Motsch. (Fig. 18)
20. Sphaeriidæ—*Sphaerius acaroides* Waltl. (Fig. 20)
21. Scaphidiidæ—*Scaphidium quadrimaculatum* Oliv. (Fig. 21)
22. Sphaeritidæ—*Sphaerites glabratus* (Fab.) (Fig. 22)
23. Histeridæ—*Hister obtusatus* Harr. (Fig. 23)

CANTHAROIDEA

24. Lycidæ—*Eros aurora* Hbst. (Fig. 24)
25. Lampyridæ—*Lucidota atra* (Fab.) (Fig. 25)
26. Phengodidæ—*Phengodes sp.* (Fig. 26)
27. Cantharidæ—*Cantharis andersoni* Frost (Fig. 27)
28. Melyridæ—*Malachius aeneus* (L.) (Fig. 28)
29. Cleridæ—*Trichodes ornatus* Say (Fig. 29)
30. Corynetidæ—*Chariessa pilosa* Forst. (Fig. 30)

LYMEXYLOIDEA

31. Lymexylidæ—*Hylocoetus dermestoides* L. (Fig. 32)

CUPEDOIDEA

32. Cupedidæ—*Cupes latreillei* Sol. (Fig. 33)

MORDELLOIDEA

33. Cephaloidæ—*Cephaloon lepturides* Newm. (Fig. 34)
34. Oedemeridæ—*Ditylus laevis* Fabr. (Fig. 35)
35. Mordellidæ—*Tomoxia bidentata* (Say) (Fig. 36)
36. Rhipiphoridæ—*Rhipiphorus dimidiatus* Fabr. (Fig. 37)
37. Meloidæ—*Nemognatha piezata* Fab. (Fig. 38)
38. Othniidæ—*Othnius kraatzi* (Fig. 31)
39. Pythidæ—*Pytho americanus* Kyb. (Fig. 39)

40. Pyrochroidæ—*Pyrochroa coccinea* L. (Fig. 40)
41. Pedilidæ—*Pedilus collaris* (Say) (Fig. 41)
42. Anthicidæ—*Notoxus calcaratus* Horn (Fig. 42)
43. Euglenidæ—*Euglenes pruinosus* (Fig. 43)

ELATEROIDEA

44. Cerophytidæ—*Cerophytum elateroides* Latr. (Fig. 44)
45. Cebrionidæ—*Cebrio gigas* Fabr. (Fig. 45)
46. Rhipiceridæ—*Sandalus segnis* (Fig. 46)
47. Elateridæ—*Alaus oculatus* (L.) (Fig. 47)
48. Melasidæ—*Eucnemis capucina* Ahrens. (Fig. 48)
49. Throscidæ—*Throscus dermestoides* L. (Fig. 49)
50. Buprestidæ—*Buprestis fasciata* Fab. (Fig. 50)

DRYOPOIDEA

51. Psephinidæ—*Psephenus lecontei* (Lec.) (Fig. 51)
52. Dryopidæ—*Potamophilus acuminatus* Fabr. (Fig. 52)
53. Helmidæ—*Helmis mangei* (Fig. 53)
54. Heteroceridæ—*Heterocerus parallelus* Kyrnick (Fig. 55)
55. Georyssidæ—*Georyssus lævicollis* Germ. (Fig. 54)

DASCILLOIDEA

56. Dascillidæ—*Dascillus cervinus* L. (Fig. 56.)
57. Helodidæ—*Scrites tibialis* Guer. (Fig. 57)

BYRRHOIDEA

58. Chelonariidæ—*Chelonarium ornatum* Klug (Fig. 58)
59. Dermestidæ—*Dermestes lardarius* L. (Fig. 59)
60. Byrrhidæ—*Byrrhus americanus* Lec. (Fig. 60)

RHYSODOIDEA

61. Rhysodidæ—*Rhysodes sulcatus* Fabr. (Fig. 61)

CUCUJOIDEA

62. Ostomidæ—*Ostoma grossa* (L.) (Fig. 62)
63. Nitidulidæ—*Prometobia sexmaculata* (Say) (Fig. 63)
64. Rhizophagidæ—*Rhizophagus picipes* (Fig. 64)
65. Monotomidæ—*Monotoma conicicollis* (Fig. 65)
66. Cucujidæ—*Cucujus clavipes* Fab. (Fig. 66)

67. Erotylidæ—*Mega lodacne grandipennis* (Fig. 67)
68. Derodontidæ—*Derodontus maculatus* (Melsh.) (Fig. 68)
69. Cryptophagidæ—*Antherophagus ochraceus* Melsh. (Fig. 69)
70. Mycetophagidæ—*Mycetophagus punctatus* Say (Fig. 70)
71. Colydiidæ—*Trachypholis ornatus* (Fig. 71)
72. Murmidiidæ—*Murmidius ovalis* Beck. (Fig. 72)
73. Lathridiidæ—*Lathridius lardarius* De G. (Fig. 73)
74. Mycetæidæ—*Mycetæa hirta* (Marsh.) (Fig. 74)
75. Endomychidæ—*Lycoperdina ferruginea* Lec. (Fig. 75)
76. Phalacridæ—*Phalacrus grossus* Erichs. (Fig. 76)
77. Coccinellidæ—*Anatis quindecimpunctata* (Oliv.) (Fig. 77)

TENEBRIONOIDEA

78. Alleculidæ—*Hymenorus melsheimeri* Csy. (Fig. 78)
79. Tenebrionidæ—*Alobates pennsylvanica* (De G.) (Fig. 80)
80. Lagriidæ—*Arthromacra ænea* (Say) (Fig. 79)
81. Monommidæ—*Monomma maximum* (Fig. 81)
82. Melandryidæ—*Penthe obliquata* (Fab.) (Fig. 82)

BOSTRICHOIDEA

83. Ptinidæ—*Oligomerus brunneus* Oliv. (Fig. 83)
84. Anobiidæ—*Sitodrepa panicea* (L.) (Fig. 84)
85. Bostrichidæ—*Apate terebrans* Pall. (Fig. 85)
86. Lyctidæ—*Lyctus linearis* (Gœze) (Fig. 86)
87. Sphindidæ—*Sphindus dubius* Gyllh. (Fig. 87)
88. Cisidæ—*Cis boleti* Scopoli (Fig. 88)

SCARABAEOIDEA

89. Scarabæidæ—*Geotrupes splendidus* (Fab.) (Fig. 89)
90. Lucanidæ—*Pseudolucanus capreolus* (L.) (Fig. 90)
91. Passalidæ—*Passalus cornutus* Fab. (Fig. 91)

CERAMBYCOIDEA

92. Cerambycidæ—*Tetraopes tetraophthalmus* (Forst.) (Fig. 92)
93. Chrysomelidæ—*Leptinotarsa decemlineata* (Say) (Fig. 93)

94. Mylabridæ—*Mylabris discoideus* Say (Fig. 94)

BRENTOIDEA

95. Brentidæ—*Eupsalis minuta* Drury (Fig. 95)

CURCULIONOIDEA

96. Platystomidæ—*Platystomus albinus* L. (Fig. 97)
97. Belidæ—*Ithycerus noveboracensis* (Forst.) (Fig. 96)
98. Curculionidæ—*Lixus concavus* Say (Fig. 98)
Asynonychus godmani Crotch (Fig. 99)

SCOLYTOIDEA

99. Platyopodidæ—*Platypus cylindricus* Fab. (Fig. 100)
100. Scolytidæ—*Dendroctonus valens* Lec. (Fig. 101)

GENERAL MORPHOLOGY

For a general discussion of the morphology of the coleopterous labium and maxilla, it is desirable to choose as a basis a generalized form exhibiting primitive characters. The extreme range in variations of the structures concerned makes the selection of a species for general description rather difficult. Many of the forms studied combine generalized and specialized features in a bewildering fashion. Since Crampton (1925) has homologized the labium of *Silpha* with the type exhibited by the primitive and "ancestral" roach, *Periplaneta,* and Forbes (1922) has indicated the primitive nature of the wing of *Silpha,* it is probably justifiable to use this genus as a basis for comparison with the rest of the Coleoptera.

LABIUM: In the labium of *Silpha americana* (Fig. 13) the gular region (*gu*) is somewhat narrowed and is not demarked from the submentum (*sm*). The gular pits (*gp*), the openings of the invaginations of the posterior tentorial arms, are considered as the anterior limits of the gula. In many Coleoptera these pits are lost with the inrolling of the head capsule and consequent obliteration of the gula, or with the extension of the posterior tentorial arms along the partial or entire length of the gular sutures. The gular sutures (*gs*) which are distinct and separated in *Silpha* demark the gula from the rest of the head capsule.

In *Silpha*, as in most of the other Coleoptera considered, the

submentum (*sm*) is not demarked from the gula but is distinct from the mentum (*mn*). The mentum, on the other hand, is usually a distinctly defined region but is very variable in contour when compared throughout the order. A membranous region, the mental membrane (*mem*), which lies between the palpigers and mentum, is present in many forms, including *Silpha*. In some cases the mental membrane is confluent with the mentum, but in *Silpha* the demarkation is definite.

The palpigers (*pgr*) bears the labial palpi (*lp*) distally and, throughout the coleopterous families, exhibit a rather wide variation of arrangement. They may be widely separated by the intervening ligula; they may be moderately separated, as in *Silpha;* and they may be contiguous or even fused indistinguishably in many instances. In the last case, it is probable that the fusion may involve the labial stipites as well as the palpigers, and since neither can be distinguished, the region of fusion is considered as the prementum.

The labial palpi (*lp*) are usually present and are three-segmented. There is a great diversity of size and shape of these three segments of the palpus. In some forms, they are so small that the palpus is hardly discernible. *Calviger* (Fig. 19) and *Eupsalis* (Fig. 95) are the only species studied in which the labial palpi are entirely lacking. The terminal segment in most forms has a membranous area at the tip which is undoubtedly sensory.

The ligula (*lg*) lies between, and distal to, the palpigers. It is formed by the union of the glossæ and paraglossæ which fuse in varying degrees. In *Silpha* the paraglossæ (*pgl*) are distinguishable as comparatively wide membranous lobes, but the glossæ have been lost in the fusion. The ligula also shows a great range of structure. It is large, broad, and sclerotized in *Laccophilus* (Fig. 5), very small in *Eros* and *Lucidota* (Figs. 24, 25), and lacking in such highly specialized forms as *Asynonychus* and *Platypus* (Figs. 99, 100).

MAXILLA: The maxilla is composed if the cardo, stipes, lacinia, galea, palpifer, and maxillary palpus. All of these structures vary greatly when compared throughout the families. The cardo (*ca*) is the most proximal segment of the maxilla. In *Silpha*

(Fig. 13), the cardo is not divided into a basicardo (*bc*) and disticardo (*dc*), nor is it so divided in most of the other beetles figured. *Cantharis* (Fig. 27), however, does exhibit this division. One of the commonest modifications of the cardo in Coleoptera is its elongation as illustrated by *Mylabris* (Fig. 94) or *Platystomus* (Fig. 97). The cardo always bears a basal process serving for the attachment of the tendons of the adductor and abductor muscles of the maxilla. The basal process of *Silpha* is not so typical as that of other beetles such, for example, as that of *Clambus* (Fig. 12), in which the tendon of the adductor muscle is attached to the inner lobe of the basal process, and the abductor muscle is attached to the outer lobe of the basal process. The point between these two lobes of the basal process serves as a pivot for articulation against the side of the submentum.

The stipes, in most of the Coleoptera figured, is composed typically of the basistipes (*bs*) and the mediostipes (*ms*). A dististipes, which is a small membranous area between the basigalea and basistipes, is present in many forms, but is probably best defined in *Cicindela* (Fig. 1) and *Silpha* (Fig. 13). The basistipes in *Silpha* is triangular in shape. Its base is contiguous with the margin of the cardo, its outer margin with the palpifer, and its inner margin with the mediostipes. In the majority of figures, the basistipes is roughly triangular in outline, but it may be broad and irregular, as in *Eros* and *Phengodes* (Figs. 24, 26), or elongate, as in *Passalus* (Fig. 91). In *Trichopteryx* (Fig. 18), the basistipes is fused with the palpifer. The mediostipes (*ms*) is, as a rule, irregular in outline and is variable in size. It is often fused with, or poorly demarked from, the lacina (*la*) (see Figs. 10, 12, 18, etc.). In the cases where the mediostipes is distinct from the lacinia, the extent of its basal margin corresponds to the area to which the basimaxillary membrane is attached. Thus, in beetles which have the mediostipes and lacinia fused, the attachment of the basimaxillary membrane determines the limit of the basal region of the mediostipes. *Tropisternus* (Fig. 9) is the only form studied in which the parastipes (*ps*) occurs. It lies between the mediostipes and the lacinia, being strongly separated from the former by a distinct suture and weakly demarked from the latter.

The maxilla typically bears two lobes, an inner lobe, the lacinia (*la*), and an outer lobe, the galea (*ga*). Some of the species figured have only one lobe which is not differentiated into a lacinia and galea. Following Böving and Craighead (1930), this single maxillary lobe is designated as the ''mala'' (*ma*) (see Figs. 8, 63, 73, etc.). Both the galea and lacinia show a remarkable range of modifications when compared throughout the Coleoptera. In many forms, the galea is divided into a basal region, the basigalea (*bg*) and a distal region, the distigalea (*dg*). The distigalea, as shown in *Silpha,* may be tipped with a dense tuft of setæ, while in other beetles it is naked (Figs. 1–8), or has setæ sparsely arranged (Fig. 17). The setæ may also be arranged in rows (Fig. 9) or in a brush (Fig. 100). The lacinia differs greatly in form, and bears setæ and spines in a number of diversified arrangements. The lateral margin of the lacinia is usually covered with setæ or spines and at its apex, as in *Silpha,* the Caraboidea, and a few other forms, may bear a digitus which in *Cicindela* (Fig. 1), is a moveable process (*dig*).

In most of the Coleoptera studied, the maxillary palpus is four-segmented, but in some more specialized forms only three segments are apparent (see Figs. 95, 96, 98, 99, etc.). The basal segment of the palpus articulates with the palpifer (*pfr*), which is usually distinct, but may be fused with the basistipes.

PHYLOGENETIC ASPECTS

ADEPHAGA

Caraboidea

A comparative study of the labium and maxilla of Coleoptera indicates that the families of the Adephaga, namely the Cicindelidæ, Carabidæ, Amphizoidæ, Omophronidæ, Haliplidæ, Dytiscidæ, and Gyrinidæ, undoubtedly form the closest and best defined group of any in the entire order. Leng (1920), Stickney (1923), and Tanner (1927) place this group as the most primitive in the phylogenetic scheme. From the standpoint of the labium and maxilla alone, however, these families exhibit specialization when compared with a form like *Silpha* (Fig. 13) which was selected as a representative of the family Silphidæ. Crampton (1925) has homologized the labium of *Silpha* with that of

the primitive and "ancestral" roach, *Periplaneta*, on the one hand, and, on the other, with the labium of the carabid, *Harpalus*. A comparison of *Harpalus* (Fig. 2) with Silpha (Fig. 13) indicates that *Harpalus* is specialized in the following features: the ligula is narrowed and crowded forward; the palpigers are elongated; the mentum is enlarged; the submentum is reduced; the gula is very narrow due to the inrolling of the head capsule and consequent invagination of the lateral areas of the gula. The maxilla of *Harpalus* also exhibits the following modifications when compared with that of *Silpha:* the cardo, stipes, and lacinia are narrowed; the membranous dististipes is lost; the galea is a slender process. In view of these facts, the family Silphidæ which is undoubtedly related to the families of the Adephaga, should be considered as more primitive than the Adephagous families.

The family Cicindelidæ, represented by *Cicindela* (Fig. 1), is considered by Leng (1920) to be the most primitive of the Coleoptera. When the figures of the labium and maxilla are compared (Figs.1, 2–7), it is evident that the family Cicindelidæ is more specialized than the rest of the Adephagous families. The ligula is lacking, the submentum is very small, and the maxilla is elongated and has an articulated digitus. Comparison of Figs. 1–7 clearly shows the similarity of structure of both the labium and maxilla throughout the Adephagous series, and it is evident that the family Paussidæ (see Fig. 8), although more highly specialized, should be included in this series.

Gyrinoidea

The superfamily Gyrinoidea includes one family, the Gyrinidæ, represented by *Dineutes* (Fig. 7). This family is so closely related to the families of the Caraboidea it should be included in this superfamily.

POLYPHAGA

Hydrophiloidea

The superfamily Hydrophiloidea contains only one family, the Hydrophilidæ, represented by *Tropisternus* (Fig. 9). According to Stickney's studies of the head capsule and Tanner's studies of the female genitalia, the Hydrophilidæ should be grouped with

the Adephaga, since its characters are similar to those of the Dytiscidæ and Gyrinidæ. The comparative study of the labium and maxilla, however, does not warrant the grouping of the Hydrophilidæ with the Adephagous families. The nature of the labium and maxilla of *Tropisternus* (Fig. 9) indicates that the family Hydrophilidæ more closely resembles some of the families of the Polyphaga, the less specialized Silphidæ, for example (see Fig. 13). This grouping of the superfamily Hydrophiloidea with the Polyphaga supports Forbes' studies of the wings and Leng's classification.

Silphoidea

The superfamily Silphoidea, as listed by Leng, includes the families Platypsillidæ, Leptinidæ, Silphidæ, Clambidæ, Scydmænidæ, and Orthoperidæ (Figs. 10–15). *Silpha* is probably the most generalized of any form figured in this series. Its resemblance to the Caraboids has already been indicated and it is also very similar to *Staphylinus* (Fig. 16) among the Staphylinoidea. Tanner places the Staphylinidæ in the silphoid series, while Forbes places the two families as very near together forming "an isolated group apparently not nearer the Polyphaga than Adephaga."

Platypsylla, although rather highly specialized, clearly resembles *Leptinus* in the characters of the labium, particularly in the lobed nature of the mentum. *Leptinus* resembles *Silpha* in the structure of both the labium and maxilla. The Scydmænid, *Euconnus,* and the Orthoperid, *Orthoperus,* also resemble *Silpha.* In the superfamily Silphoidea, the labium in characterized by a broad ligula, a comparatively long submental region demarked from the head capsule laterally, and distinct gular sutures and gular pits. The maxilla in all forms has the mediostipes confluent with the lacinia, and the galea divided into a basigalea and distigalea.

Staphylinoidea

The superfamily Staphylinoidea is comprised of eight families, namely, the Staphylinidæ, Pselaphidæ, Clavigeridæ, Ptilidæ, Sphæriidæ, Scaphidiidæ, Sphæritidæ, and Histeridæ (Figs. 16–23). In this superfamily, the labium and maxilla show a rather

diversified structure as indicated in the figures. As mentioned above, *Staphylinus* strongly resembles *Silpha* in having the submentum comparatively long and confluent with the narrow gula, in having gular sutures and pits distinct, and in having the structure of the maxilla essentially similar. The silphoid family Clambidæ, represented by *Clambus* (Fig. 12), resembles the staphylinoid families Ptilidæ, represented by *Trichopteryx* (Fig. 18), and Sphæriidæ, represented by *Sphærius* (Fig. 20). In these three families, the general character of the maxilla is the same. The gular region is short, and the submentum is only weakly demarked from the head capsule. *Scaphidium* and *Hister* are alike in having confluent gular sutures and a reduced submental region. *Pselaphus,* although specialized, bears a striking resemblance to *Euconnus. Claviger,* which is also specialized, can be placed near *Pselaphus.*

Cantharoidea

The superfamily Cantharoidea is a comparatively close knit group which includes the families Lycidæ, Lampyridæ, Phengodidæ, Cantharidæ, Melyridæ, Cleridæ, and Corynetidæ (Figs. 24–30). Within this group, the Lycidæ and Lampyridæ as represented by *Eros* and *Lucidota* are very similar. In both forms the gula is short and broad, the mentum and submentum are small and weakly demarked, the palpigers are fused, and the ligula and labial palpi are essentially alike. The maxillæ are also very similar. The Phengodidæ and Cantharidæ, represented by *Phengodes* and *Cantharis,* can be grouped together. The gula in these two forms is longer than in *Eros* and *Lucidota.*

The clerid, *Trichodes,* and Corynetid, *Charriessa,* are strikingly similar in the structure of the maxilla. Both of the last two genera in the general characters seem to resemble the members of the Mordelloidea more closely than they resemble the members of the Cantharoidea as is indicated by the breadth of the ligula, the demarkation of the mentum, the development of the gula, the division of the maxillary galea into a basigalea and distigalea, and the development of a long, distinct lacinia. The family Melyridæ as represented by *Malachius* resembles the Cleridæ in having a similar structure of the labium. In both

cases, the ligula is membranous, the palpigers are contiguous, and the mentum is weakly developed and poorly demarked from the mental membrane. In *Malachius,* the submentum is weakly demarked from the gula and the gular pits extend the length of the gula sutures, while in *Trichodes,* the submentum is confluent with the gula and the gular pits extend the length of the gular sutures. The above mentioned affinities of the Cantharoidea are in general agreement with Stickney's views of the group.

Lymexyloidea

Unfortunately, a single family of the Lymexyloidea must be relied upon in attempting to determine the affinities of this group, because representatives of the other two families, the Telegeusidæ and Micromalthidæ, were unobtainable. The Lymexylidæ are represented in this discussion by *Hylcoetus.* Although rather specialized, this genus seems to resemble the Dryopoid genus *Psephenus* (Fig. 51), particularly in the structure of the maxilla. In both genera, the stipes is not differentiated into a basistipes and mediostipes and is confluent with the lacinia, and the palpifer is a ring-like segment. In the labium in both forms, the palpigers are contiguous, or nearly so, and the submentum is weakly demarked from the head capsule and is confluent with the wide gula. Stickney and Tanner both place this superfamily with the Cucujoidea.

Cupedoidea

The Cupedoidea contains one family, the Cupedidæ, represented by *Cupes* (Fig. 33). Although the form studied is somewhat specialized, the labium resembles this structure in some of the families of the Mordelloidea. The palpigers are widely separated, the mentum is large, the submentum is weakly demarked from the head capsule and is confluent with the gula as is the case in representatives of the Cephaloidæ and Mordellidæ (Figs. 34, 35). Apparently the superfamily Cupedoidea should be grouped with the superfamily Mordelloidea as Stickney and Tanner have indicated.

Mordelloidea

Representatives of eleven of the twelve families listed under the superfamily Mordelloidea have been figured (see Figs. 31,

34–43), and the group, as a whole, shows considerable homogeneity of structure in the labium and maxilla. In the labium in most of these forms, the ligula is broad and bilobed, the mentum is well developed, the submentum is confluent with the long gula and is demarked from the head capsule, and the gular pits are usually distinct. In the maxilla, the mediostipes is, in most cases, demarked from the lacinia, and the galea in divided into a basigalea and distigalea. The Rhipiphoridæ and the Meloidæ, represented by *Rhipiphorus* and *Nemognatha,* show a striking similarity in the great elongation of the distigalea of the maxilla and the close association of the lacinia with the basigalea.

As Stickney has pointed out, the Oedemeridæ, Cephaloidæ, Pyrochroidæ, Pedilidæ, and Anthicidæ are closely related. All of these forms (see Figs. 34, 35, 40, 41, 42) have the ligula broad and bilobed, the mentum distinct, and the submentum confluent with the long gular region. In all but *Notoxus,* which represents the Anthicidæ, the mediostipes of the maxilla is demarked from the lacinia. The general nature of the labium and maxilla of *Othnius, Tomoxia,* and *Pytho* would seem to group the families Othniidæ, Mordellidæ, and Pythidæ within this series.

Elateroidea

The superfamily Elateroidea, as listed by Leng, includes the families Cerophytidæ, Cebrionidæ, Plastoceridæ, Rhipiceridæ, Elateridæ, Melasidæ, Throscidæ, and Buprestidæ (Figs. 44–50). A representative of all of these families has been figured except for the Plastoceridæ. The Cerophytidæ, represented by *Cerophytum,* the Melasidæ, represented by *Eucnemis,* and the Throscidæ, represented by *Throscus,* seem to be related. In these three forms, the submentum and gula are broad and greatly shortened, the mentum is well developed, the palpigers are contiguous, or nearly so, and the maxillary galea and lacinia are short and comparatively broad.

The representatives of the Elateridæ and Buprestidæ, *Alaus* and *Buprestis,* are similar, particularly in the structure of the maxilla. The mediostipes is demarked from the lacinia, and the lacinia is comparatively short and is membranous in its basal region. In the labium, the mentum is broad and bears a weak, transverse, median division, the gula is broad, and the gular pits

are distinct. The Cebrionidæ, represented by *Cebrio,* resembles the Elaterid, *Alaus.* The ligula is bilobed, the mentum is weakly divided transversely, and the maxillary mediostipes is demarked from the short lacinia. The family Rhipiceridæ, represented by *Sandalus,* is probably related to the Cantharoids. The general nature of the labium and maxilla seem to ally it with the characters found in this group.

Dryopoidea

The superfamily Dryopoidea is composed of the families Psephinidæ, Dryopidæ, Helmidæ, Heteroceridæ, and Georyssidæ (Figs. 51–55). With the exception of *Georyssus* and *Psephenus,* this group seems to be related to the Elateroidea. *Georyssus* seems to resemble *Hister.* Comparison of Figs. 54 and 23 shows a similarity in the structure of the labium and maxilla. The ligula is bilobed; the mentum is distinct; the submentum is tapered posteriorly; the gular region, which has been obliterated by the inrolling of the head capsule, is represented by a median suture; the mediostipes of the maxilla is demarked from the lacinia; the lacinia is slender; and the palpifer is large.

The shortened submental and gular regions in the Heteroceridæ, represented by *Heterocerus,* would suggest its relation to the Cerophytidæ, Melasidæ, and Thoroscidæ. *Potamophilus,* representing the Dryopidæ, and *Helmis,* representing the Helmidæ, are similar. The palpigers are contiguous; the mentum is distinct; the submentum is weakly demarked from the narrow gula; the lacinia of the maxilla is comparatively long; the galea is divided into a basigalea and distigalea; and the mediostipes is weakly demarked from the lacinia in *Potamophilus,* and is confluent with the lacinia in *Helmis.*

Dascilloidea

The superfamily Dascilloidea includes two families, the Dascillidæ and Helodidæ (Figs. 56, 57). The similarities in the characters of the labium show that these two families are probably closely related. The mentum is wide and distinctly demarked, the submentum is demarked from the head capsule, and is confluent with the wide gula. In the maxilla of the Helodid, *Scirtes,* the mediostipes is demarked from the lacinia, while in *Dascillus* it is confluent with the lacinia.

Byrrhoidea

In the superfamily Byrrhiodea, representatives of the Chelonariidæ, Dermestidæ, and Byrrhidæ have been figured (Figs 58–60). Stickney includes the Chelonariidæ in the Dascilloidea. Comparison of Fig. 58 with Fig. 56 shows that, although *Chelonarium* is somewhat more specialized than *Dascillus,* the two genera are undoubtedly closely related and therefore the Chelonariidæ are perhaps more appropriately grouped with the Dascilloidea than with the Byrrhiodea. *Dermestes* and *Byrrhus* (Figs. 59, 60) are apparently closely related to the Cucujoidea and are therefore discussed with this group.

Rhysodoidea

The superfamily Rhysodoidea contains one family, the Rhysodidæ, represented by *Rhysodes* (Fig. 61). This form is so specialized that it is difficult to place it with any degree of certainty. The development of the mentum and the narrowing of the gula suggest a relationship to the Cucujoidea in general, and to *Cucujus* in particular.

Cucujoidea

The superfamily Cucujoidea, according to Leng, includes more families than any other superfamily. Representatives of seventeen of the eighteen families have been figured, a representative of the Monoeidæ being unobtainable (Figs. 62–77). The Nitidulidæ and Lathridiidæ, represented by *Prometobia* and *Lathridius* (Figs. 63, 73), are alike in having the mentum very broad, the submentum broad and not demarked from the head capsule, and only a single maxillary lobe, the mala, present.

The Rhizophagidæ, Derodontidæ, Cryptophagidæ, Colydiidæ, and Dermestidæ (see Figs. 64, 68, 69, 71, 59) are alike in having the mentum well developed, the submentum confluent with the gula and demarked from the head capsule, the gula broad, and the gular pits distinct. The maxilla has the mediostipes confluent with, or weakly demarked from, the lacinia, except in *Dermestes* which has the demarkation distinct. In all of these forms, the lacinia and galea are comparatively long and slender, and, in all except *Rhizophagus,* the galea is divided into a basigalea and distigalea, and the lacinia terminates in a claw-like process.

The Erotylidæ, Murmidiidæ, Mycetaeidæ, Endomychidæ, and Phalacridæ (Figs. 67, 72, 74, 75, 76) are similar in having the mentum well developed; the submentum short and demarked from the encroaching head capsule, which widely separates the distinct region of the submentum from the gula; and the gula extremely short and demarked by distinct gular pits. The maxilla in this group, with the exception of the Mycetaeidæ, has the galea divided into a basigalea and distigalea; the lacina long and slender; and the mediostipes demarked from the lacina, except in the Erotylidæ. The family Monotommidæ, represented by *Monotoma* (Fig. 65), probably belongs in this group, although the gula is somewhat longer in this form, and the gular pits extend the length of the gular sutures.

The Ostomidæ, Cucujidæ, and Mycetophagidæ (Figs. 62, 66, 70) have the anterior region of the submentum wide and demarked from the head capsule, and the posterior region narrowed and confluent with the gula. The gular pits are distinct in *Mycetophagus,* but extend the length of the gular sutures in *Ostoma* and *Cucujus.*

Byrrhus (Fig. 60) does not resemble any genus figured for the Cucujoidea in all respects, but is similar to the more specialized *Ostoma* (Fig. 62) in the characters of the labium and maxilla. The Coccinellidæ, represented by *Leptinotarsa* (Fig. 77), might be placed either with the Cucujoidea, or with the Tenebrionoidea.

Several families of the Cucujoidea strongly resemble families of the Mordelloidea, showing that these two groups are, without doubt, closely related. *Cucujus* (Fig. 66) is very similar to *Pytho* (Fig. 39) in the characters of the labium and maxilla. The Mordelloids *Tomoxia, Pedilus, Pyrochroa, Notoxus,* etc. (Figs. 35, 40, 41, 42, etc.) resemble such Cucujoids as *Rhizophagus* and *Derodontus* (Figs. 64, 68) in their general characters.

Tenebrionoidea

The superfamily Tenebrionoidea includes the Alleculidæ, Tenebrionidæ, Lagriidæ, Monommidæ, and Melandryidæ (Figs. 78–82). These families form a comparatively homogenous group. In all of these families excepting the Monommidæ, represented by *Monomma* (Fig. 81), the labium has the anterior region of the submentum broad, and at least weakly demarked from the en-

croaching capsule, and the posterior region either obliterated or represented by a median suture, as in *Arthromacra* (Fig. 80), or by a Y-shaped suture, as in *Alobates* and *Penthe* (Figs. 79, 82). The gular pits extend along the gular sutures in *Arthromacra,* but are distinct in the other genera. The maxillae are similar in all the forms figured in this group. The mediostipes is demarked from the lacinia and the galea is divided into a basigalea and distigalea. The Tenebrionoidea as a whole seem closely related to the Mordelloidea and Cucujoidea.

Bostrichoidea

The superfamily Bosterichoidea is comprised of the Ptinidæ, Anobiidæ, Bostrichidæ, Lyctidæ, Sphindidæ, and Cisidæ (Figs. 83–88). The Ptinidæ and Sphindidæ (Figs. 83, 87) are similar in having the ligula bilobed and sclerotized, the submentum weakly demarked from the head capsule, the gular pits extending along the gular sutures, the mediostipes confluent with the lacinia, and the galea not divided into a basigalea and distigalea.

The Anobiidæ, Bostrichidæ, and Lyctidæ (Figs. 84, 85, 86) have a trilobed ligula, distinct gular pits, a comparatively slender gula, the maxillary mediostripes confluent with, or weakly demarked from, the lacinia, and the galea divided into a basigalea and distigalea. The family Cisidæ represented by *Cis* (Fig. 88) is rather specialized in the loss of the ligula, the narrowing of the labium, and the shortening of the galea and lacinia. Except for the loss of the ligula, the labium resembles that of the Mordelloid family Rhipiphoridæ (Fig. 37).

Scarabaeoidea

The superfamily Scarabaeoidea includes the Scarabæidæ, Lucanidæ, and Passalidæ, represented by *Geotrupes, Pseudolucanus,* and *Passalus* (Figs. 89, 90, 91). This group is homogeneous, and is undoubtedly related to the families of the Adephaga and their close relatives. The mentum is very broad, the submentum is broad and weakly demarked from the wide gula, the gular pits extend along the gular sultures, and the maxillary mediostipes is confluent with, or only weakly demarked from, the lacinia. *Passalus* (Fig. 91) resembles *Amphizoa* (Fig. 6), particularly in the character of the maxilla, and apparently is more specialized

than *Geotrupes* and *Pseudolucanus*. *Geotrupes* appears to be the least specialized of this series. In this form, the mentum and submentum are not so broad, the ligula is sclerotized and bilobed, and the palpigers are widely separated. *Pseudolucanus* would seem to occupy an intermediate position between *Geotrupes* and *Passalus*. The mentum and submentum are wide. The ligula is bilobed and sclerotized, and the palpigers are narrowly separated. In *Passalus* the mentum and submentum are wide, the ligula is broad and sclerotized, and the palpigers are fused in the premental region.

Cerambycoidea

The superfamily Cerambycoidea is composed of three families, the Cerambycidæ, Chrysomelidæ, and Mylabridæ (Figs. 92, 93, 94). These families form a homogeneous group in which the ligula is broad and sclerotized, or partly so, the palpigers are fused in the premental region, a mental membrane is present, the mentum is short, and the maxillary mediostipes is confluent with the lacinia or weakly demarked from it. In *Tetraopes* (Fig. 92), the submentum is confluent with the wide gula, and the gular pits extend along the gular sutures. Except for the demarkation of the anterior region of the submentum, *Leptinotarsa* resembles *Tetraopes* in the nature of the submentum and gula. *Mylabris* has the anterior region of the submentum enlarged and cut off from the narrowed gula by the encroaching head capsule.

Brentoidea

The superfamily Brentoidea has one family, the *Brentidæ*, represented by *Eupsalis* (Fig. 95). This genus is highly specialized and should be included in the superfamily Curculionoidea, to which it is closely related. The labium lacks the labial palpi and palpigers; the mentum is confluent with the elongated submentum; the gula has been obliterated, and is represented by a median gular suture; the maxillary cardo and stipes are fused to form a narrow strip; there is a single maxillary lobe; and the maxillary palpus is three-segmented.

Curculionoidea

The superfamily Curculionoidea includes the Platystomidæ, Belidæ, and Curculionidæ. The family Platystomidæ, represented

by *Platystomus* (Fig. 97), although highly specialized, suggests the Adephaga in the breadth of the labium and general nature of the maxilla, found in the Adephagous family Cicindelidæ. The family Belidæ, represented by *Ithycerus* (Fig. 96), resembles the more specialized Scolytidæ, represented by *Dendroctonus* (Fig. 101). The ligula in both of these forms is short; the palpigers are lacking; the mentum is wide in *Ithycerus,* but narrow in *Dendroctonus;* the submentum is long and wide in *Ihycerus,* but short and confluent with the head capsule laterally in *Dendroctonus;* and, in both, the gula is represented by a median suture. The maxilla in *Dendroctonus* is more highly specialized in having the basistipes, mediostipes, and palpifer fused and in having a single maxillary lobe, the mala, present. In *Ithycerus,* however, the basistipes, mediostipes, palpifer, galea, and lacinia are all distinctly demarked. In both of these genera, the maxillary palpus is three-segmented.

The family Curculiondæ is represented by *Lixus,* a form with a long snout (Fig. 98), and *Asynonychus,* a form with a short snout (Fig. 99). Both of these genera are specialized. *Lixus* has minute labial palpi, a comparatively broad ligula, a greatly elongated submental region, and the gula represented by a median suture. In the maxilla, the stipes is not differentiated into a basistipes and mediostipes, and is confluent with the mala. *Asynonychus* has the labial palpi larger, but lacks the ligula, and the submental region is short. The maxilla has the stipes weakly differentiated into a basistipes and mediostipes, and the galea and lacinia are both present. In both of these genera, the maxillary palpus is three-segmented.

Scolytoidea

The superfamily Scolytoidea includes two families, the Scolytidæ (Fig. 101) discussed above, and the Platypodidæ, represented by *Platypus* (Fig. 100). *Platypus* is also specialized, especially in the features of the maxilla. The labium is similar to that of *Asynonychus,* but the maxilla appears to resemble that of *Eupsalis.*

In summarizing the affinites of the superfamilies of the Coleoptera as indicated by the comparative study of the labium and maxilla, two principal groups are recognizable which agree with

Stickney's grouping of the superfamilies based on the study of the head capsule. The first of these groups includes the following superfamilies: Caraboidea, Gyrinoidea, Hydrophiloidea, Silphoidea, Stanphylinoidea, Cantharoidea (in part), and Scarabaeoidea.

The second and larger group includes the following superfamilies: Cantharoidea (in part), Lymexyloidea, Mordelloidea, Elateroidea, Dryopoidea, Dascilloidea, Byrrhoidea, Rhysodoidea, Cucujoidea, Tenebrionoidea, and Bostrichoidea.

The superfamilies Cerambycoidea, Brentoidea, Curculionoidea, and Scolytoidea might be grouped separately. Due to the specializations occurring in them, it is extremely difficult to determine to which of these two main groups they are most closely related.

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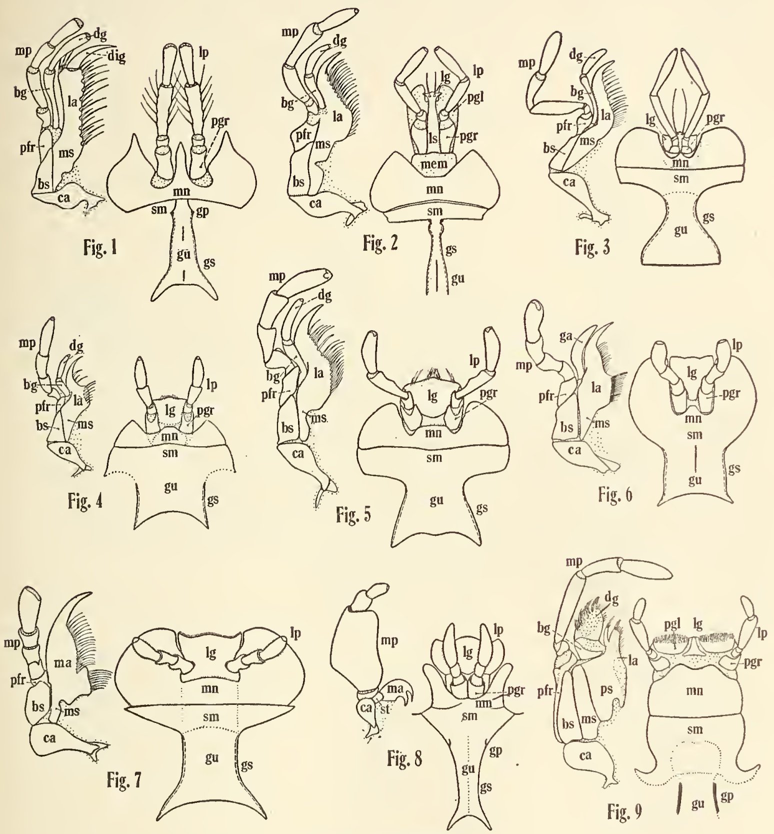
Each figure includes a line drawing in ventral aspect of the labium and maxilla of representatives of the following Coleopterous families:

PLATE XIII

Figure 1. Cicindelidæ—*Cicindela sexguttata* Fab.
Figure 2. Carabidæ—*Harpalus caliginosus* (Fab.)
Figure 3. Omophronidæ—*Omophron americanum* Dej.
Figure 4. Haliplidæ—*Laccophilus maculosus* (Germ.)
Figure 5. Dytiscidæ—*Colymbetes sculptilis* Harr.
Figure 6. Amphizoidæ—*Amphizoa isolens* Lec.
Figure 7. Gyrinidæ—*Dineutes vittatus* (Germ.)
Figure 8. Paussidæ—*Paussus hova*
Figure 9. Hydrophilidæ—*Tropisternus glaber* (Hbst.)



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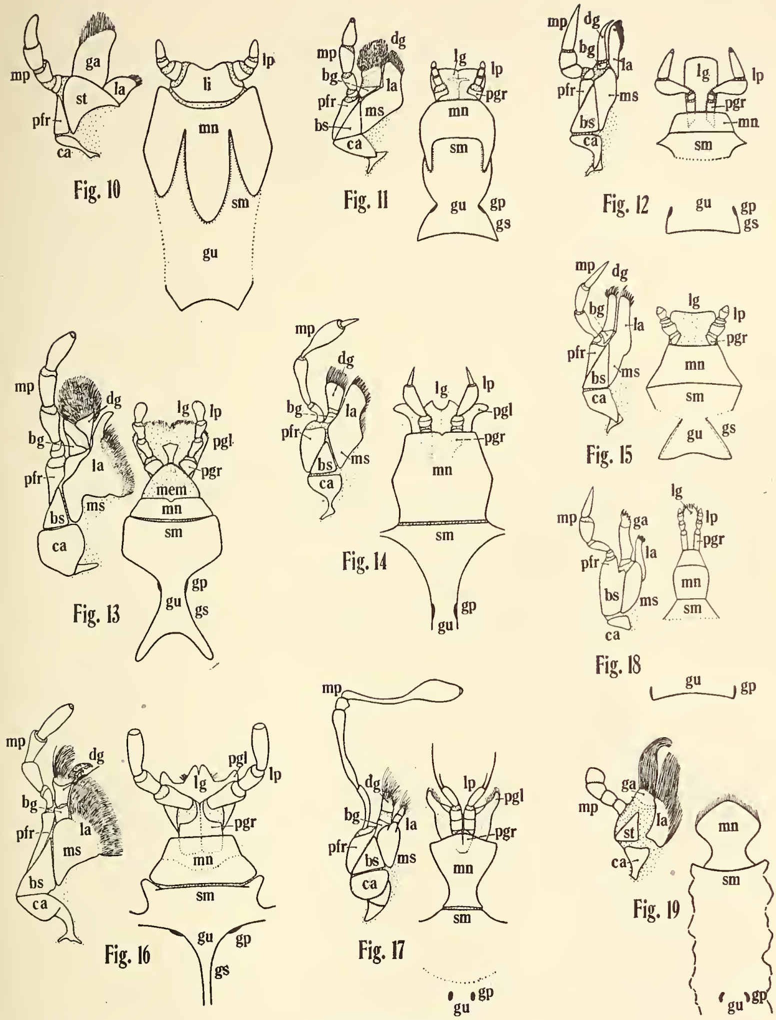
COLEOPTERA

PLATE XIV

Figure 10. Platypsyllidæ—*Platypsyllus castoris* Rits.
Figure 11. Leptinidæ—*Leptinus testaceus* Müll.
Figure 12. Clambidæ—*Clambus punctulatum* Beck.
Figure 13. Silphidæ—*Silpha americana* L.
Figure 14. Scydmænidæ—*Euconnus similis* Blatch.
Figure 15. Orthoperidæ—*Orthoperus brunnipes* Gyll.
Figure 16. Staphylinidæ—*Staphylinus vulpinus* Nordm.
Figure 17. Pselaphidæ—*Pselaphus dresdensis* Herbst.
Figure 18. Ptilidæ—*Trichopteryx lata* Motsch.
Figure 19. Clavigeridæ—*Clavigera testaceus*



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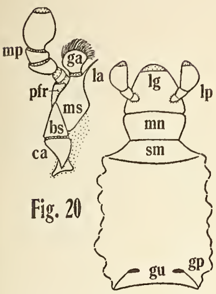
COLEOPTERA

PLATE XV

Figure 20. Sphæriidæ—*Sphærius acaroides* Waltl.
Figure 21. Scaphidiidæ—*Scaphidium quadrimaculatum* Oliv.
Figure 22. Sphæritidæ—*Sphærites glabratus* (Fab.)
Figure 23. Histeridæ—*Hister obtusatus* Harris
Figure 24. Lycidæ—*Eros aurora* Hbst.
Figure 25. Lampyridæ—*Lucidota atra* (Fab.)
Figure 26. Phengodidæ—*Phengodes* sp.
Figure 27. Cantharidæ—*Cantharis andersoni* Frost.
Figure 28. Melyridæ—*Malachius æneus* (L.)



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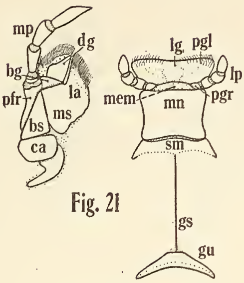

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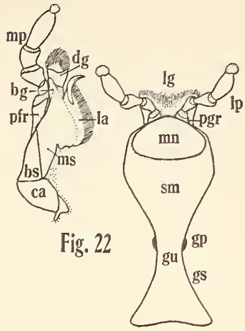

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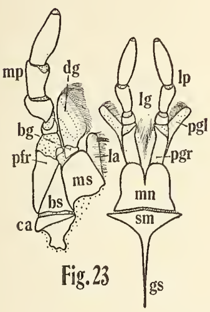

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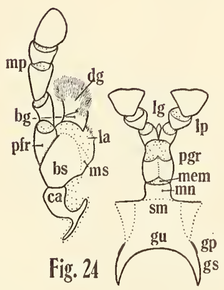

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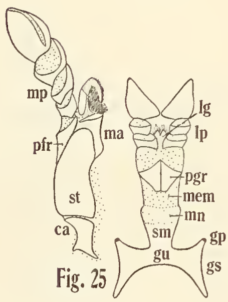

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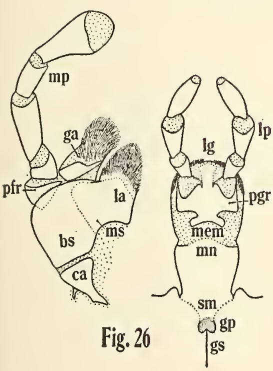

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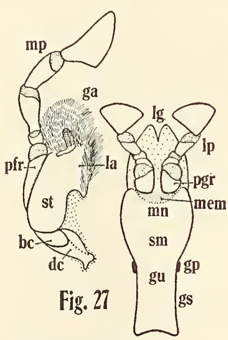

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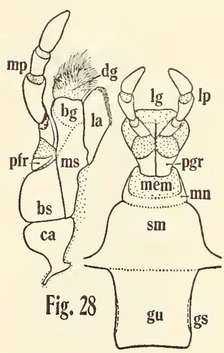
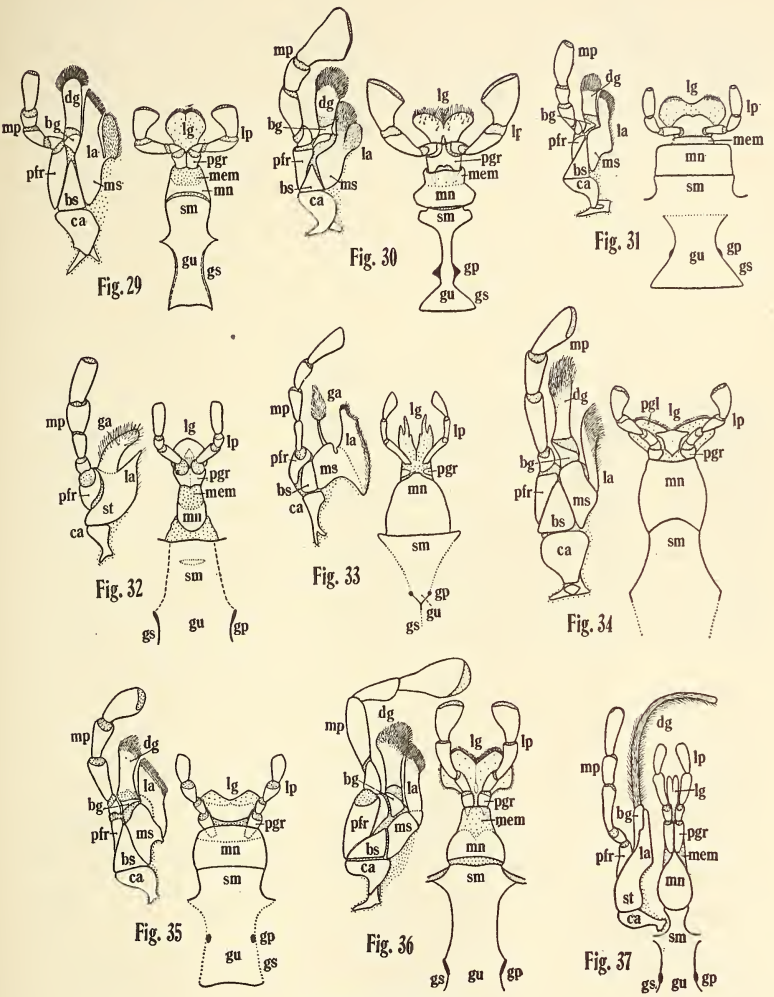


Fig. 28

COLEOPTERA

PLATE XVI

Figure 29. Cleridæ—*Trichodes ornatus* Say
Figure 30. Corynetidæ—*Chariessa pilosa* Forst.
Figure 31. Othniidæ—*Othnius kraatzi*
Figure 32. Lymexylidæ—*Hylocœtus dermestoides* L.
Figure 33. Cupesidæ—*Cupes latrellei* Sol.
Figure 34. Cephaloidæ—*Cephaloon lepturides* Newm.
Figure 35. Œdemeridæ—*Ditylus lævis* Fabr.
Figure 36. Mordellidæ—*Tomoxia bidentata* (Say)
Figure 37. Rhipiphoridæ—*Rhipiphorus dimidiatus* Fabr.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COLEOPTERA

Plate XVII

Figure 38. Meloidæ—*Nemognatha piezata* Fab.
Figure 39. Pythidæ—*Pytho americanus* Kby.
Figure 40. Pyrochroidæ—*Pyrochroa coccinea* L.
Figure 41. Pedilidæ—*Pedilus collaris* (Say)
Figure 42. Anthicidæ—*Notoxus calcaratus* Horn
Figure 43. Euglenidæ—*Euglenes pruinosus*
Figure 44. Cerophytidæ—*Cerophytum elateroides* Latr.
Figure 45. Cebrionidæ—*Cebrio gigas* Fabr.
Figure 46. Rhipiceridæ—*Sandalus segnis*

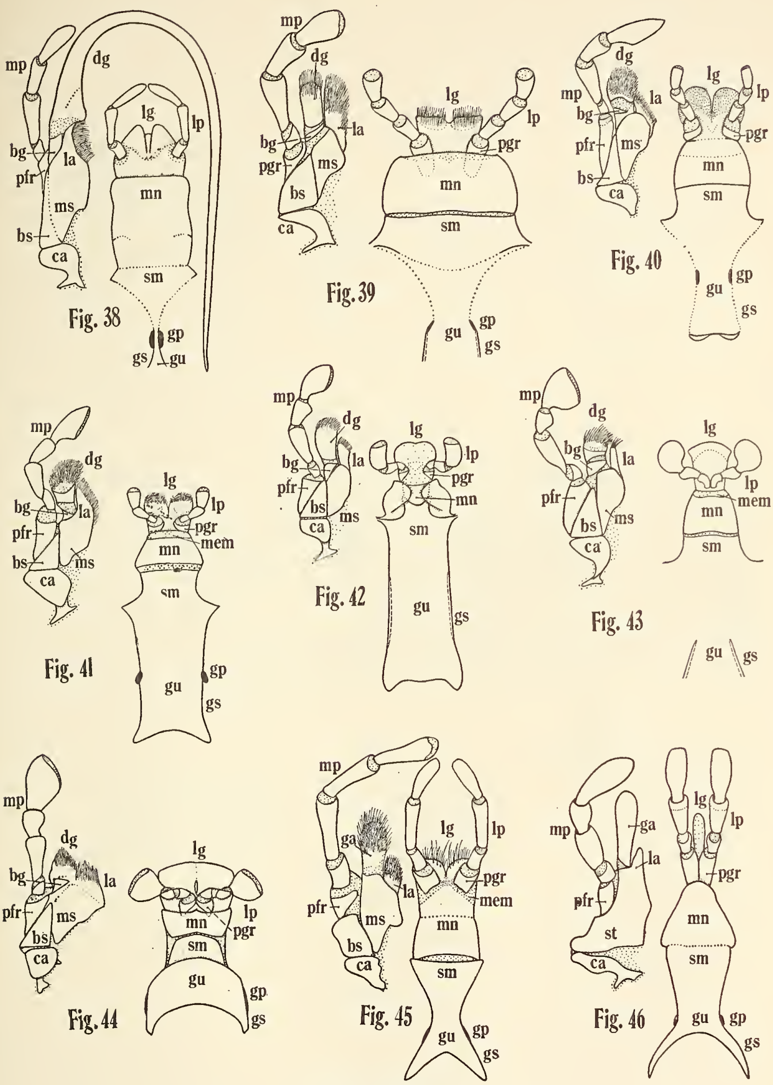
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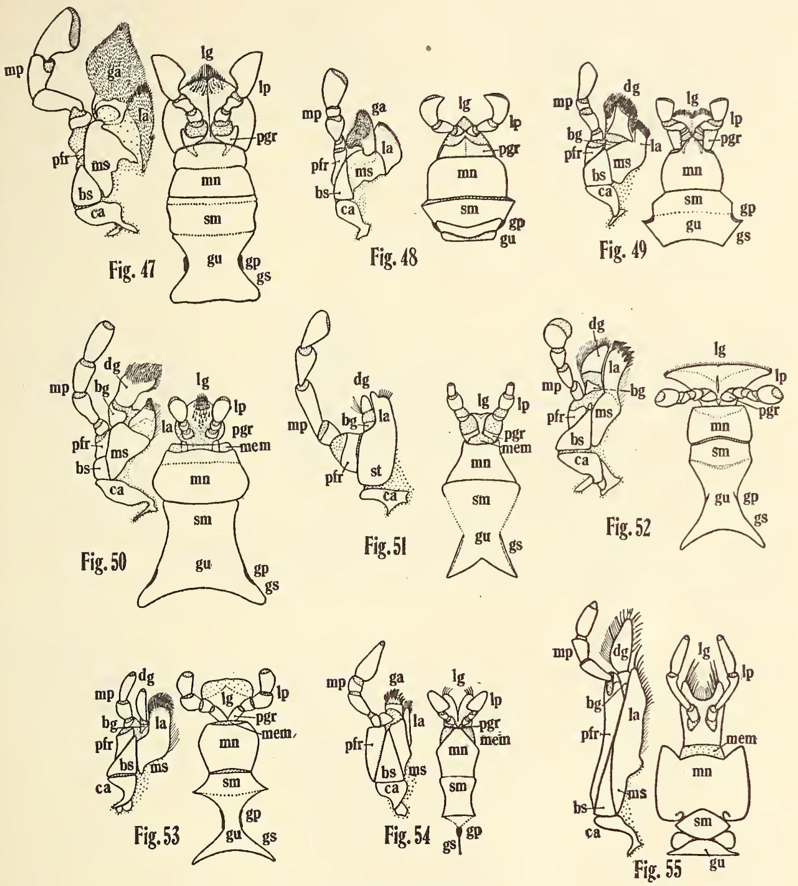
PLATE XVIII

Figure 47. Elateridæ—*Alaus oculatus* (L).
Figure 48. Melasidæ—*Eucnemis capucina* Ahrens.
Figure 49. Throscidæ—*Throscus dermestoides* L.
Figure 50. Buprestidæ—*Buprestis fasciata* Fab.
Figure 51. Psephenidæ—*Psephenus lecontei* (Lec.)
Figure 52. Dryopidæ—*Potamophilus acuminatus* Fabr.
Figure 53. Helmidæ—*Helmis mangei*
Figure 54. Georyssidæ—*Georyssus lævicollis* Germ.
Figure 55. Heterocidæ—*Heterocerus parallelus* Krynick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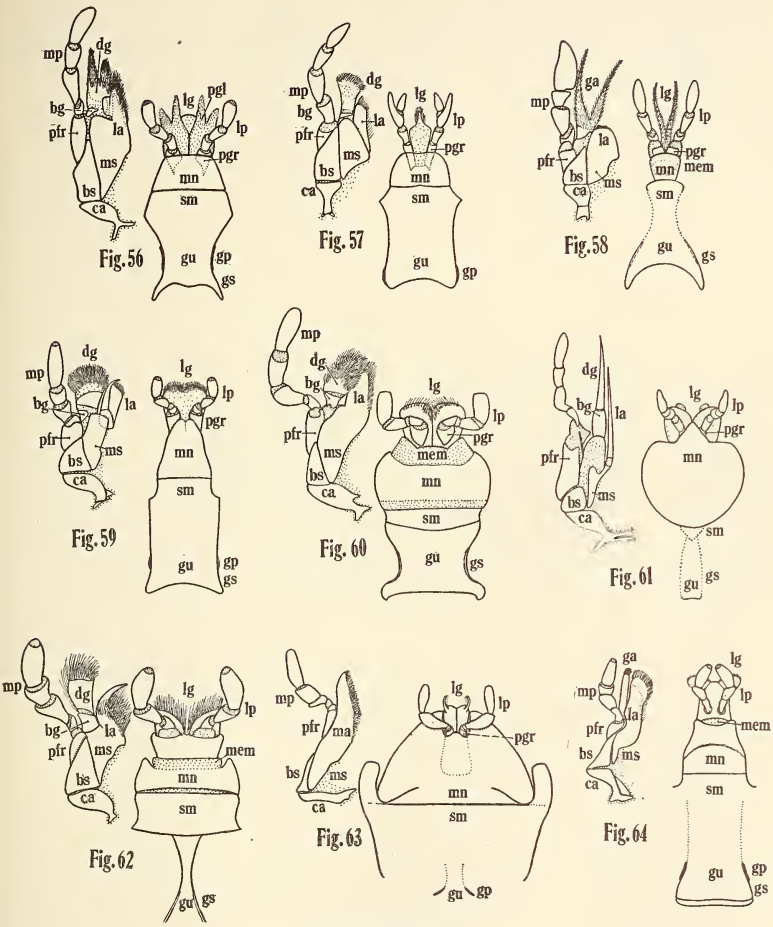
COLEOPTERA

PLATE XIX

Figure 56. Dascillidæ—*Dascillus cervinus* L.
Figure 57. Helodidæ—*Scirtes tibialis* Guer.
Figure 58. Chelonariidæ—*Chelonarium ornatum* Klug
Figure 59. Dermestidæ—*Dermestes lardarius* L.
Figure 60. Byrrhidæ—*Byrrhus americanus* Lec.
Figure 61. Rhysodidæ—*Rhysodes sulcatus* Fabr.
Figure 62. Ostomidæ—*Ostoma grossa* (L.)
Figure 63. Nitidulidæ—*Prometobia sexmaculata* (Say)
Figure 64. Rhizophagidæ—*Rhizophagus picipes* Walker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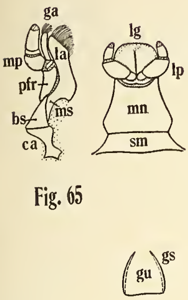
COLEOPTERA

PLATE XX

Figure 65. Montomidæ—*Monotoma conicicollis*
Figure 66. Cucujidæ—*Cucujus clavipes* Fab.
Figure 67. Erotylidæ—*Megalodacne grandipennis*
Figure 68. Derodontidæ—*Derodontus maculatus* Melsh.
Figure 69. Cryptophagidæ—*Antherophagus ochraceus* Melsh.
Figure 70. Mycetophagidæ—*Mycetophagus punctatus* Say
Figure 71. Colydiidæ—*Trachypholis ornatus*
Figure 72. Murmidiidæ—*Murmidius ovalis* Beck.
Figure 73. Lathridiidæ—*Lathridius lardarius* De G.



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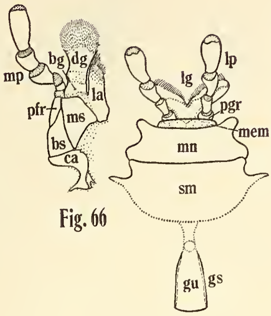

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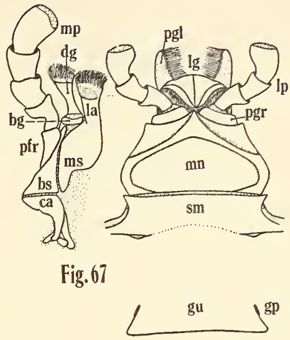

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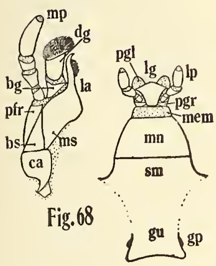

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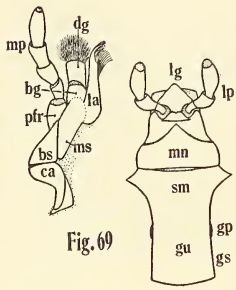

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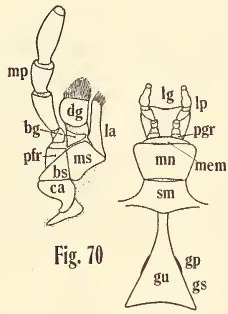

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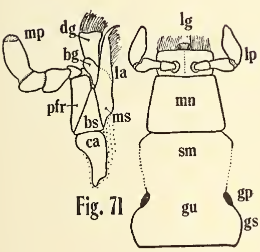

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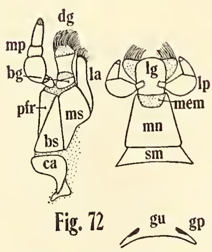

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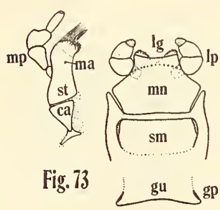
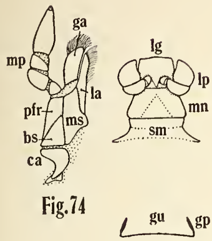


Fig. 73

COLEOPTERA

PLATE XXI

Figure 74. Mycetæidæ—*Mycetœa hirta* (Marsh.)
Figure 75. Endomychidæ—*Lycoperdina ferruginea* Lec.
Figure 76. Phalachridæ—*Phalacrus grossus* Erichs.
Figure 77. Coccinellidæ—*Anatis quindecimpunctata* (Oliv.)
Figure 78. Alleculidæ—*Hymenorus melsheimeri* Csy.
Figure 79. Lagriidæ—*Arthromacra æenea* (Say)
Figure 80. Tenebrionidæ—*Alobates pennsylvanica* (De G.)
Figure 81. Monommidæ—*Monomma maximum*
Figure 82. Melandryidæ—*Penthe obliquata* (Fab.)



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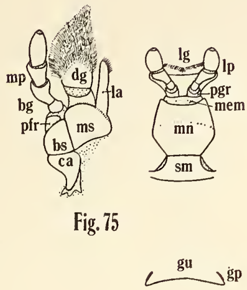

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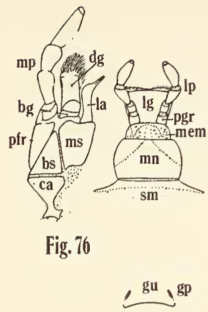


Fig. 76

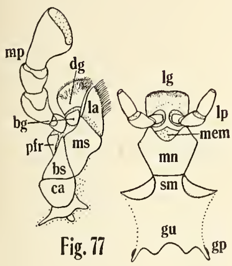


Fig. 77

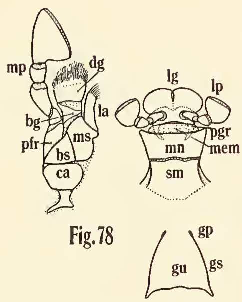


Fig. 78

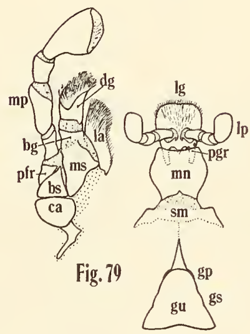


Fig. 79

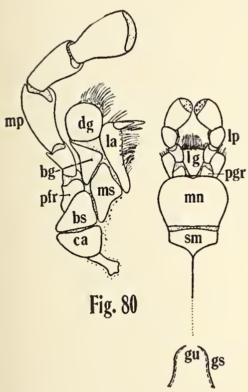


Fig. 80

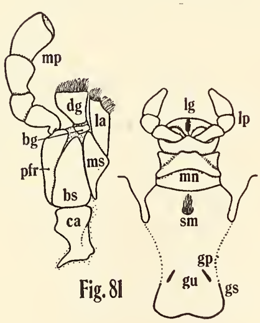


Fig. 81

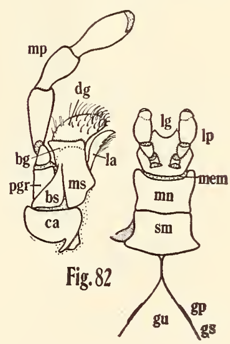


Fig. 82

COLEOPTERA

PLATE XXII

Figure 83. Ptinidæ—*Oligomerus brunneus* Oliv.
Figure 84. Anobiidæ—*Sitodrepa panicea* (L.)
Figure 85. Bostrichidæ—*Apate terebrans* Pall.
Figure 86. Lyctidæ—*Lyctus linearis* (Goeze)
Figure 87. Sphindidæ—*Sphindus dubius* Gyllh.
Figure 88. Cisidæ—*Cis boleti* Scopoli
Figure 89. Scarabæidæ—*Geotrupes splendidus* (Fab.)
Figure 90. Lucanidæ—*Pseudolucanus capreolus* (L.)
Figure 91. Passalidæ—*Passalus cornutus* Fab.

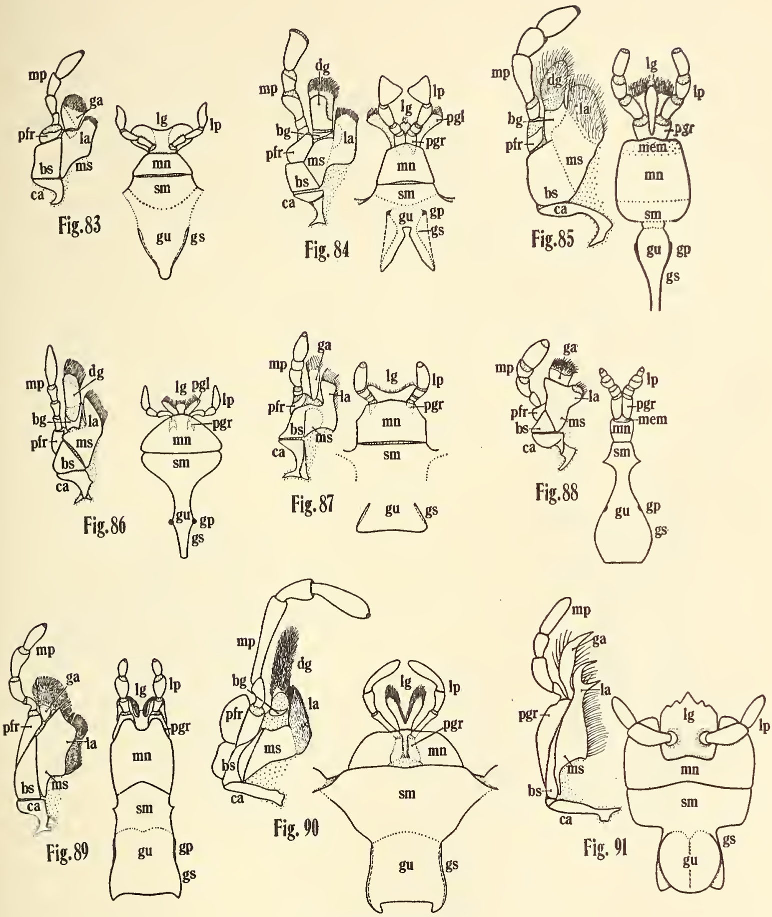


Fig.83
mp ga pfr la bs ms ca
lg lp mn sm gu gs
Fig. 84
mp dg bg la pfr ms bs ca
lp lg pgl pgr mn sm gu gp gs
Fig.85
mp dg bg la pfr ms bs ca
lg lp pgr mem mn sm gu gp gs
Fig.86
mp dg bg la pfr ms bs ca
lg pgl lp pgr mn sm gu gp gs
Fig.87
ga mp la pfr bs ms ca
lg lp pgr mn sm gu gs
Fig.88
ga mp la pfr ms bs ca
lp pgr mem mn sm gu gp gs
Fig.89
mp ga pfr la bs ms ca
lg lp pgr mn sm gu gp gs
Fig. 90
mp dg bg la pfr ms bs ca
lg lp pgr mn sm gu gs
Fig. 91
mp ga la pgr ms bs ca
lg lp mn sm gs gu

COLEOPTERA

PLATE XXIII

Figure 92. Cerambycidæ—*Tetraopes tetraophthalmus* (Forst.)
Figure 93. Chrysomelidæ—*Leptinotarsa decemlineata* (Say)
Figure 94. Mylabridæ—*Mylabris discoideus* Say
Figure 95. Brentidæ—*Eupsalis minuta* Drury
Figure 96. Belidæ—*Ithycerus noveboracensis* (Forst.)
Figure 97. Platystomidæ—*Platystomus albinus* L.
Figure 98. Curculionidæ—*Lixus concavus* Say
Figure 99. Curculionidæ—*Asynonychus godmani* Crotch
Figure 100. Platypodidæ—*Platypus cylindricus* Fabr.
Figure 101. Scolytidæ—*Dendroctonus valens* Lec.

ABBREVIATIONS

bc—basicardo
bg—basigalea
bs—basistipes
ca—cardo
dc—disticardo
dg—distigalea
dig—digitus
ga—galea
gl—glossa
gp—gular pit
gs—gular suture
gu—gula
la—lacinia
lg—ligula
li—labium
lp—labial palp
ls—labial stipes
ma—mala
mem—mental membrane
mn—mentum
mp—maxillary palpus
ms—mediostipes
pfr—palpifer
pgl—paraglossa
pgr—palpiger
ps—parastipes
sm—submentum
st—stipes

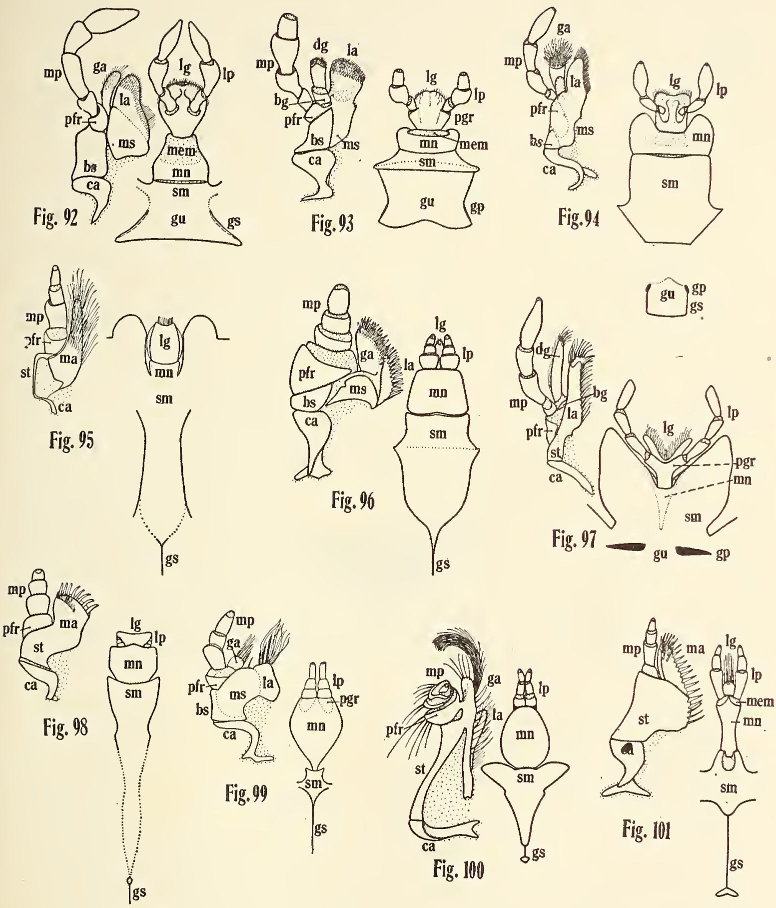


Fig. 92 Fig. 93 Fig. 94 Fig. 95 Fig. 96 Fig. 97 Fig. 98 Fig. 99 Fig. 100 Fig. 101

CORRECTION

June 1938, vol. XLVI, No. 2, p. 193, line 1: Dr. Stanley W. Bromley, who has examined the specimen, writes us that the insect identified as *Stenopogon longulus* Loew is *S. inquinatus* Loew.—Robert Y. Pratt and Melville H. Hatch.

NEW NORTH AMERICAN CICADAS WITH NOTES ON DESCRIBED SPECIES*

BY WILLIAM T. DAVIS
STATEN ISLAND, N. Y.

Magicicada and Cœnomyia

In June, 1928, brood II of the Seventeen-Year Cicada occurred on Staten Island, and the insects were in great numbers in the woods on the hillside forming the westerly rim of the Clove Valley. This area is now included in the Clove Lakes Park. On June 11 the writer visited the locality; saw several cicadas feeding on oak, and others on black birch, and was surprised to find the fly *Cœnomyia ferruginea* Scopoli, or possibly it should be called *pallida* Say. This species had not been collected on the Island, and six females and two males were found; also the pupal skins of eleven females and thirteen males. The pupal skins were protruding from the ground where the cicadas were thickest, and it appeared that the predaceous fly larvæ must have been interested in them. On June 15 sixteen additional pupal skins of *Cœnomyia* were collected at the same locality as those mentioned above. On June 17, 1928, the remains of a *Cœnomyia* fly were discovered on top of a large boulder on Old Place meadow, about four miles to the west of Clove Valley, where it had been left by a bird.

In 1929 there were a few belated Seventeen-Year Cicadas in the Clove Valley, and on June 14 four female and two male *Cœnomyia* pupal skins were collected. In 1930 no trace of *Cœnomyia* could be discovered at the above mentioned locality, nor has the fly been found there again.

Brood II of the Seventeen-Year Cicada occurred in great numbers in 1911 in the Military Reservation at West Point, and while we did not associate it with *Cœnomyia* at the time, it is of interest that on June 3 and 4 we collected 10 males and 9 females of *ferruginea*.

* I am indebted to Mr. Hans L. Stecher for drawing the text figures, and to Mr. Carlton Beil for taking the photographs.—W. T. D.

In 1936 Brood X of the Seventeen-Year Cicada appeared. They were particularly numerous in parts of western New Jersey and eastern Pennsylvania. On June 4, Dr. James P. Chapin and the writer found them very plentiful in a wood near Krumsville, Berks County, Pa., and associated with them were *Cœnomyia* flies, and many fly pupal skins protruded from the ground among the numerous holes from which the cicadas had emerged.

In the "Bulletin of the Illinois State Laboratory of Natural History," Vol. XII, March, 1917, there is an article on the flies of the family Cœnomyiidæ by J. R. Malloch. It is there stated that *Cœnomyia* larvæ feed on white grubs, and from the above mentioned observations they also appear to be interested in cicadas.

In Bulletin No. 71, U. S. Department of Agriculture, 1907, it is stated that during their subterranean existence the larvæ and pupæ of the Periodical Cicada, "when near the surface, are doubtless subject to the attacks of various predaceous coleopterous larvæ, and many of them are unquestionably destroyed by this agency." In the Proceedings Entomological Society of Washington, February, 1921, p. 44, F. C. Craighead records the rearing of the beetle *Sandalus niger* from a cicada pupa.

Tibicen marginalis (Walker). Variety **pronotalis,** new variety. (Plate XXIV, Fig. 1.)

Type, male, Wasta, S. D., July 22, 1935 (P. W. Oman), collection U. S. National Museum.

Allotype, Elk Point, S. D., August 10, 1924 (H. C. Severin), collection Wm. T. Davis.

The species occurs from Ohio, Kentucky, Tennessee, Alabama and western Florida, westward to the Dakotas, Nebraska, Kansas, Oklahoma and eastern Texas. In this wide range it shows some variation and examples from the Dakotas, Iowa, Oklahoma and Nebraska are usually smaller and quite often have a rather large central black mark on the pronotum, more rarely present in specimens from Texas, Missouri, Tennessee, Illinois and Ohio, or in the eastern range of the species. An examination of about 100 specimens from Louisiana disclosed but two with an all black spot on the pronotum.

In the JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY

for March, 1925, page 39, this variety of *Tibicen marginalis* was described as follows, but no name was proposed: ''While the pronotum is often entirely green or yellowish-green in this species, there is a rather conspicuous color variety with an irregular oblong, black spot, centrally, extending backward to the collar. Black lines sometimes lead from this spot each side into the oblique grooves. This variety probably occurs throughout the range of the species, but is much more common near its northern limit. When freshly emerged this cicada may have a dorsal row of pruinose spots on the abdomen, as in *dorsata, dealbata* and *cultriformis,* but is easily separated from them by the more bent fore margin of the front wings, very broad head, form of the uncus, as well as by color characters.''

Specimens with the black mark on the pronotum usually have the inverted *resh* shaped characters on the mesonotum considerably smaller than in those without the mark.

In 1927 the following specimens of *marginalis* were examined for Prof. H. C. Severin, Brookings, S. D., all from Elk Point, S. D.: male and four females, August 10, 1924; male June 24, 1926; male August 17, 1927. The allotype was of this lot, and the following note was made at the time: ''All have clear black spot on the pronotum, except the 1927 male, where there is a pale spot included in the black one. This male more like those common to the southward.'' In the collection of the Museum of Zoology, University of Michigan, there is a typical female *pronotalis* collected along the Missouri River in Charles Mix County, South Dakota, by C. L. Hubbs, July 6, 1934, and in the collection of the University of Kansas there is a male and a female collected at Wasta, South Dakota, by M. B. Jackson, July 17, 1937.

In Oklahoma the variety here designated as *pronotalis* appears to be more numerous than the typical form, and six specimens have been examined from Osage, Pawnee, Le Flore and McCurtain counties, while three typical examples have been seen from Osage and McCurtain counties.

Recently Prof. H. E. Jaques, of Iowa Wesleyan College, sent me five typical *marginalis* from Polk, Muscatine and Henry counties, Iowa, and seven specimens of variety *pronotalis* from Monona and Linn counties, which were so strikingly different

from the typical form that a new variety name was considered desirable.

Cicada marginata was named by Thomas Say in 1825 from Missouri, and it is stated that the head and thorax [pronotum] are "greenish yellow slightly varied with black; scutel [mesonotum] black with the W and elevated X greenish-yellow." In 1852 Walker changed the name to *Cicada marginalis* to distinguish it from *C. marginata* Olivier of 1790. An account of the habits and distribution of *marginalis* is given in the JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, June, 1935, pp. 176–178.

Tibicen cultriformis from southeastern Arizona and southwestern New Mexico, described and figured in the JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, December, 1915, and March, 1925, bears a close resemblance to *T. marginalis* var. *pronotalis*, much more so than it does to typical *marginalis*. Each has a conspicuous black spot, though of slightly different shape on the pronotum, but the genitalia are quite unlike, and are as figured in 1915 on Plate 18.

MEASUREMENTS IN MILLIMETERS

Variety *pronotalis*	Male Type	Female Allotype
Length of body	37	33
Width of head across eyes	15	15
Expanse of fore wings	103	104
Greatest width of fore wing	17	17
Width of operculum	7	

Tibicen paralleloides Davis

This species was described and figured in the JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY for March, 1934, and again mentioned in the June, 1936, number. Only two males, and one female supposed to belong to this species, had been examined previous to 1937, when Albert E. Maas sent me two males and three females collected in October at Compostela, Nayarit, Mexico, the type locality. Later a male from the same locality was received from Miss E. Rosenbauer.

From the brightly colored females that sex may be more fully described. On each side of the abdomen there is a minute prui-

nose spot at base; a large spot, as in the male on segment three, and a slightly smaller one on segment four. The notch in the last ventral segment is shallow, with a small round dark spot each side. These specimens lack the small but conspicuous red spots present in *T. parallela* along the sides of the abdomen, one on the hind margin of each segment.

Diceroprocta bicosta (Walker)

The localities of the two specimens from which Walker made the original description in 1850 were unrecorded, but Distant in Biol. Centr. Amer., Homoptera, 1881, figures as *bicosta* a female from Mexico, expanding 100 mm., and adds that the species also occurs in Costa Rica. The male was unknown to him. In the writer's collection of 15 specimens, there is but a single male. One female is without locality; the others were collected as follows: Tela Guaimas district, Honduras, May 2, 1923 (T. H. Hubell). Two additional females from Honduras are in the collection of the University of Michigan. One male, 9 females from Jojutla, Morelos, Mexico, June, 1929. Two females from Nayarit, Mexico, July 28, 1935, and October 12, 1935. Lastly a female found near Mission San Ignacio, Sonora, Mexico, July, 1936, about 40 miles south of Nogales, Arizona (Ned J. Burns).

This species will probably be found in the United States, and indeed has been reported from Key West, Florida, by P. R. Uhler. He states, Transactions, Maryland Acad. Sciences, 1892, page 154: "In my own collection there is a female from Key West, Florida, captured by Dr. E. Palmer, and a male from Cape St. Lucas, Lower California, from the cabinet of John Xantus deVesey." It is probable that the Key West specimen should be referred to *biconica* Walker, and the one from Cape St. Lucas to *digueti* Distant, described in 1906, after the publication of Uhler's paper.

Diceroprocta alacris (Stål)

The specific name *alacris* Stål appears as a synonym for a Mexican cicada under the name *transversa* Walker, but *alacris*, in our opinion, is the correct name for the species.

The first *Cicada transversa* was described by Germar in Thon's Ento. Archiv. 11, p. 7 (1830). According to Distant's Catalogue

of 1906, Germar's species equal *Cicada atra* of Olivier, described in 1790, and so became a synonym. This is a Palæarctic species.

The second *Cicada transversa* was described from Vera Cruz, Mexico, by Walker in Insecta Saundersiana, Homoptera, p. 15 (1858). As this name had been used by Germar in 1830, it should not have been used again in 1858 it was a preoccupied name. *Cicada alacris* Stål, Stettin, Ento. Zeitung, XXV, p. 62 (1864), is next in priority as a name for this Mexican insect. The species was cited by Stål in 1870 as an example of his subgenus *Diceroprocta*. See JOURNAL NEW YORK ENTOMOLOGICAL SOCIETY, Dec., 1928, pp. 439–440.

In "Biologia Centrali Americana," Rhynch. Hom., page 7, Distant states that he is "indebted to Dr. Signoret for the opportunity of comparing *types* of this species with those of Walker in the British Museum." On page 9 he records that he had examined Stål's *type* and found it to be a synonym of *C. transversa* Walker. In the JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY for 1928, plate XVII, there is a figure of the type of *transversa* Walker, received from the British Museum.

The original description of *alacris* calls for a blackish insect variegated with olivaceous, olivaceous yellow, or greenish olivaceous. The original description of *transversa* from Vera Cruz calls for a black insect variegated with testaceous. It states: "Prothorax testaceous with six irregular black stripes. Mesothorax testaceous along the border and with five testaceous stripes; the inner pair ramose."

In "Biologia Centrali Americana," Tab. 2, Fig. 1, *transversa* is figured by Distant. The collar, or posterior margin of the prothorax, is shown as green, and the anterior margins of the fore wings, yellowish. The collar and the anterior margin of the fore wing to end of radial area are usually of the same color, at least this is the case in the 17 specimens of *alacris* under examination at this time. Three males are from Vera Cruz without date; a female from Puerto Mexico, Vera Cruz, dry bushes near the seashore, 26 June, 1928, from Dr. Dampf; male Frontera, Tabasco, sea level on light, 9 June, 1928, from Dr. Dampf; male and female, Yucatan, Progreso, Cerro Isla Cienaga, 30 July, 1932 (E. P. Creaser). These specimens are blackish variegated with olivaceous or olivaceous yellow.

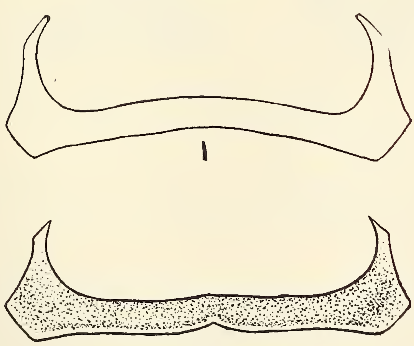
In addition to the above there are ten females of what is here designated an orange variety, of a very different appearance, which show some structural variation. If a male were at hand it would likely prove to be a distinct species.

Diceroprocta alacris (Stål). Variety **campechensis**, new variety. (Plate XXIV, Fig. 2.)

Type female from Laguna de Terminos, Campeche, Mexico, September 11, 1936 (H. D. Thomas). Collection University of Kansas.

The broad orange collar has a noticeable indentation or sinus centrally on the hind margin not observed in the olivaceous yellow form. Also the collar is rather conspicuously flecked with a multitude of fine streak-like dark spots. The costal margin of the fore wings is orange to end of radial area. General color of the body above brown, with an irregular black band connecting the eyes; ocelli ruby colored. Pronotum brown with the grooves black and black along the anterior margin of the orange collar, which has a noticeable marginal black spot at each extremity. Mesonotum brown, the four obconical spots black, the two innermost rather small. Hind margin orange, except the X which is pale brown or orange in some of the paratypes. Abdomen dark brown or black above with the hind margin of each segment often paler, or brownish-green.

The ten females, including the type, collected by Mr. H. D. Thomas, September 11, 1936, occurred in very tall grass six or



1

2

1. Diceroprocta alacris
2. D. alacris var. campechensis

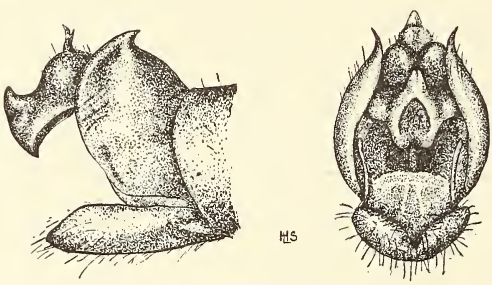
MEASUREMENTS IN MILLIMETERS

	Female Type
Length of body	25
Width of head across eyes	10
Expanse of fore wings	80
Greatest width of fore wing	11

seven feet high, along Rio Chumpan at Hacienda Balchacaj, located about the middle of the south shore of Laguna de Terminos, Campeche, Mexico.

Diceroprocta bakeri (Distant). (Plate XXIV, Fig. 4.)

This species was described as *Rihana bakeri* in the "Pomona College Journal of Entomology," Vol. iii, No. 3, September, 1911, from specimens collected by D. L. Crawford at Cuernavaca, Mexico.



DICEROPROCTA BAKERI

ico. Distant states that: "By the markings of the tegmina, allied to *R. swalei* Dist." In the collection of Cornell University there are three additional males from Cuernavaca collected by Crawford and labeled *Rihana bakeri.* In the writer's collection there are five males and a female from the type locality collected June, 1922, by Mrs. E. P. Hinton.

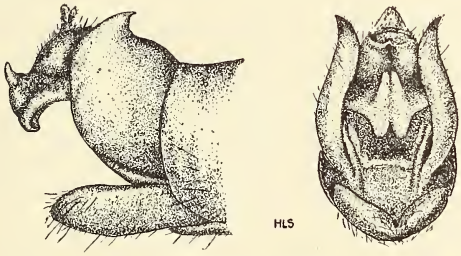
The following description of a closely allied species from Western Mexico, is modified from that of *bakeri* to cover the new species.

Diceroprocta tepicana, new species. (Plate XXIV, Fig. 3.)

Type male and allotype female from near Compostela, Nayarit, formerly Tepic, Mexico, May, 1937 (Elvira Rosenbauer). Davis collection.

Resembles in size and general color *Diceroprocta bakeri* Distant, from south central Mexico, but is larger and has the eyes more prominent and more separated at sides from pronotum; the opercula are short, oblique, apically rounded, not extending beyond the base of the abdomen with the internal angles considerably separated in the type, whereas in the 6 males of *bakeri* they more nearly touch. The notch of the last ventral segment in the female of *tepicana* is double, that is has one notch within the other, whereas in *bakeri* it is single.

Head with the front black and a small ochraceous spot at apex; vertex ochraceous almost covered by a large transverse black fascia extending between the eyes; ocelli red. Pronotum ochraceous, a central longitudinal fascia angularly dilated anteriorly and posteriorly, and the furrows black; the anterior margin narrowly and the posterior margin or collar broadly, pale ochraceous. Mesonotum ochraceous or olive green, with a large central quadrate spot united to a long obconical spot on each lateral area, black, the central spot is marked by a looped ochraceous line, and each lateral spot is outwardly ochraceous; the central spot is also narrowly longitudinally united with the basal cruciform elevation, before the anterior angles of which is a small black spot. Abdomen above blackish, the tympanal coverings and the posterior margin of each segment testaceous. Body beneath and legs almost entirely pale, with a darker central area at the base of the abdomen. The basal membranes or anal areas in both fore and hind wings grayish, and darker than in *bakeri*, while the apical portions of the fore wings are not as suffused.



DICEROPROCTA TEPICANA

MEASUREMENTS IN MILLIMETERS

	Male Type	Female Allotype
Length of body	19	20
Width of head across eyes	8	9
Expanse of fore wings	60	68
Greatest width of fore wing	8	10
Greatest width of operculum	3	

In addition to the type and allotype a single female from Compostela is in the writer's collection.

Diceroprocta delicata (Osborn). Variety **aurantiaca,** new variety. (Plate XXIV, Fig. 5.)

Type male and allotype female from 10 mi. SE Pecos, Reeves County, Texas, July 11, 1936 (Dr. Raymond H. Beamer and associates). Collection University of Kansas.

Cicada delicata Osborn was described in the "Ohio Naturalist," Vol. VI, p. 498, April, 1906, from five males and one female collected at the Gulf Biologic Station, Cameron, Louisiana, by Prof. J. S. Hine and J. B. Garrett. The length was given to tip of abdomen, 18 mm., to tip of elytra, 27 mm.; width of head and eyes, 8 mm. The cross veins of the elytra deeply infuscated. "Color light green, especially pronounced on front; legs except tarsi, hinder margin of pronotum, basal portion of elytral veins, vertex, hinder portion of pronotum and disc of mesothorax, opercula and abdomen below ochery-yellow, dorsum of abdomen tinged with testaceous. A transverse irregular band produced backwardly to occiput and including the reddish ocelli and dorsal portion of front and eyes, black. The anterior portion of pronotum is marked with two spots extending from the black margins of the vertex. The anterior part of mesothorax includes four cuneiform black spots, the outer portion is also infuscated becoming a fairly distinct black posteriorly and there are two distinct black points just in front of the elevated X of the scutellum. The tip of the rostrum and claws to tarsi and spines of hind tibiæ are blackened but otherwise under portion is pallid."

In this JOURNAL for March, 1916, one of the five typical males from Cameron, Cameron County, La., was figured on Plate 6, figure 2, Prof. Herbert Osborn having sent it to the writer for comparison.

Since 1916 several hundred specimens of *delicata* have been examined, and it is found that those from Louisiana and along the Gulf Coast to Brownsville, Texas, are usually pale in color and answer well the original description. Seven males from the University of Kansas, collected as far inland as San Antonio, July 4, 1936, are like many from closer to the Gulf. In Hidalgo County,

and in Starr County, as well as in neighboring counties in Texas, a darker variety appears in which the green, black and orange colors are more strongly contrasted. They, however, have the obconical spots on the mesonotum following the usual pattern, that is the outer pair longest, reaching backward to the limbs of the X. The tympana are generally black or nearly so. Mr. Paul C. Avery has sent me about 250 of this form from Mission, Hidalgo County. In 1928 the writer noted in connection with the 140 specimens of *delicata* collected by the University of Kansas expedition of that year, that the 8 collected on July 30 in Starr County, and the 34 collected July 28 and August 14 in Hidalgo County, had the colors darker and more contrasted than the 18 from Cameron County, August 3, and the 80 from Aransas County collected August 6 and 9th.

The darker colored form of *delicata* extends up the Rio Grande until the vicinity of Eagle Pass or the 100th meridian, is reached, when a greater change takes place. The appearance of the cicadas is so changed that they might be considered to be of a different species from the small, pale individuals found in the vicinity of the coast, if it were not for the intermediate forms. The insects average larger than the typical form; are orange in color; the dorsum of the abdomen somewhat darker, and the veins bordering the marginal areas of the fore wings are often heavily infuscated. The inner pair of obconical spots on the mesonotum are as in the coastal form, but the outer pair are greatly reduced, being often represented by very small triangular black marks. The legs are orange.

For this variety or geographic race, as described above, the name *aurantiaca* is proposed.

Measurements in Millimeters

	Male Type	Female Allotype
Length of body	22	22
Width of head across eyes	8	9
Expanse of fore wings	58	62
Greatest width of fore wing	9	9.5
Greatest length of operculum	4	

In addition to the type and allotype, 41 male and 3 female topotypes, collected July 11, 1936, have been examined, as well as 4 males and one female collected July 11, 1936, at Malaga, New Mexico, by Dr. Raymond H. Beamer and his associates. A single male *aurantiaca,* labeled Pecos River, Sheffield, Texas, July 4, 1917, has been sent to me by Dr. H. H. Knight. In the collection of the Museum of Zoology, University of Michigan, there are 45 examples of *aurantiaca* collected July 22, 1935, by I. J. Cantrall, along the Pecos River in Texas at Barstow in Ward County and Pecos in Reeves County. At Del Rio the specimens collected on the low land near the Rio Grande by George P. Engelhardt and the writer, July 9, 1931, belong to *aurantiaca,* but in several individuals show a nearer approach in color characters to the eastern form than do the specimens from Pecos County. This is also true of 6 specimens from Uvalde County, Texas, collected by Dr. Knight, July 2, 1917.

In his thesis on: "The Cicadas of Texas," June, 1936, F. F. Bibby mentions several color forms of *delicata,* including the one here described as variety *aurantiaca.*

Mr. Paul C. Avery reports *delicata* found on land subject to overflow, or at least damper than adjoining land, and often on willow. He has collected the species at Mission, Hidalgo County, Texas, from June to September, and J. W. Monk found it in 1933 at Donna, in Hidalgo County, as late as October 16.

A similar variation toward an orange color has been shown to exist in *Diceroprocta cinctifera* as the Rio Grande is ascended. Individuals with greenish or yellowish-green collar and front margin to the fore wings, known as variety *viridicosta* Davis, are found from the Gulf to about Eagle Pass, replaced further up the river in Texas and New Mexico by the typical *cinctifera* Uhler. Along Limpia Creek, a branch of the Pecos River, *Diceroprocta cinctifera* variety *limpia* Davis is found. (See JOUR. N. Y. ENT. SOC., March, 1930, p. 60, and June, 1932, p. 246.)

Proarna cocosensis Davis

This species was described and figured in this JOURNAL for June, 1935, page 191, from two males and one female. The cicadas in the Carnegie Museum at Pittsburgh, Pa., were ex-

amined June 5, 1936, and Dr. Hugo Kahl showed me seven males, six females and a number of nymphal skins of *cocosensis* collected February 10, 1936, by Reynold L. Fricke, when the yacht ''Vagabondia'' visited Cocos Island. Some of these have been compared with the specimens included in the original description, and the characteristic heavy Cu1b vein in the fore wings found to be the same.

Herrera lugubrina (Stål)

In ''Biologia Centrali Americana,'' Rhynch. Hom., *Carineta lugubrina* Stål, Stett. Ent. Zeit. xxv, p. 57 (1864), is figured. In his 1906 Catalogue Distant places it in the genus *Herrera.* The original description states that it is blackish, opaque with the tegmina and wings dirty vitreous veined with fuscous. Long 10–13, expanse of tegmina 30–36 mill. The head rather obtuse and the thorax in front a little wider than the head and eyes with the lateral margins parallel towards apex beyond the middle wider at base with a transverse groove quite near the hind margin.

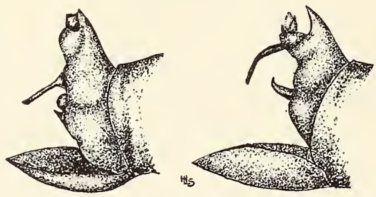
In the writer's collection there are 95 specimens from Compostela, Nayarit, Mexico, that resemble this species, but Mr. W. E. China of the British Museum, who has kindly compared specimens from this series states that they ''appear to represent a new species.'' As so many of the cicadas from Compostela have proved to be undescribed it is likely that this *Herrera* should at least be separated as a variety of *lugubrina* pending the accumulation of more specimens.

Herrera lugubrina (Stål). Variety **compostelensis**, new variety. (Plate XXIV, Fig. 7.)

Type male, allotype female, Compostela, Nayarit, Mexico, August, 1936. Davis collection.

Paler than *lugubrina,* and pronotum rarely blackish. Front pale yellowish or greenish yellow; black band connecting eyes; pronotum yellowish or olivaceous, with a central band bifurcated in front; grooves blackened and an oblique black spot each side near the collar, which has the anterior margin black and the posterior margin pale. Mesonotum with four obconical marks; the X olivaceous, with a fuscous spot immediately in front. Abdomen

greenish yellow with a dorsal row of spots, sometimes absent or nearly so; also a row of spots each side which extend over the margin to the underside, where there is a median row of spots. In the males the spots usually do not extend quite to the end of the abdomen. Legs pale, striped with black. Membranes at base of fore and hind wings yellowish.



1. HERRERA LATICAPITATA
2. H. LUGUBRINA VAR. COMPOSTELENSIS

MEASUREMENTS IN MILLIMETERS

	Male Type	Female Allotype
Length of body	12	13.5
Width of head across eyes	4	4
Expanse of fore wings	34	35
Greatest width of fore wing	7	7

This insect occurs in July and August, and as it has been taken for the past six years, must be fairly common.

Herrera laticapitata new species. (Plate XXIV, Fig. 8.)

Type male and allotype female from Huixtla Valley near Vergel, Chiapas, Mexico, June 24, 1935. Found on a tree, and received from Dr. A. Dampf to whom the type has been returned.

Differs from the description of *Herrera* (*Carineta*) *lugubrina* Stål, and variety *compostelensis* Davis, in having the head across the eyes broader than the front part of the pronotum. Also the front of the head is much more tumid and prominent. It is blackish with "tegmina and wings dirty vitreous varied with fuscous," as in *lugubrina*, but the membranes at base of fore and hind wings dark olivaceous and not yellowish. Front olivaceous, a broad black band connecting the eyes. Pronotum olivaceous with a central band bifurcated in front and joining the black collar at the posterior margin. The hind margin of the collar is not narrowly pale, nor are the grooves blackened. Mesonotum with the usual four obconical marks; X olivaceous with a fuscous

spot in front. Abdomen clouded with fuscous. Beneath, the head, except the pale front, black; the pronotum and mesonotum mottled with black. Abdomen paler than the thorax and without the central longitudinal dark band of spots as in *lugubrina* variety *compostelensis*. Legs pale; opercula small, arcuate, apically fuscous and not bordered with pale.

MEASUREMENTS IN MILLIMETERS

	Male Type	Female Allotype
Length of body	13	14
Width of head across eyes	5	5
Expanse of fore wings	38	37
Greatest width of fore wing	7	6.5

Okanagana aurora Davis

At the time this beautiful insect was described (JOUR. N. Y. ENT. SOC., June, 1936) but three specimens were known to me, all collected near Mammoth, Mono County, California. Three additional specimens, two males and a female, collected at McGee Creek, Mono County, California, July 7, 9 and 11, 1932, have been examined in the collection of the Carnegie Museum, Pittsburgh, Pa.

Okanagana tanneri Davis

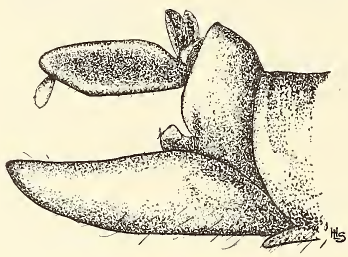
This insect was described in this JOURNAL, March, 1930, from three males collected at Woodside, Emery County, Utah, and later Prof. Tanner sent five males and twelve females taken at the same locality and time as the type. A male collected at Gateway, Mesa County, Colorado, June 29, 1932 (L. G. Davis) is in the collection of the University of Kansas, and on June 18, 1933, Prof. G. F. Knowlton, collected two males at Cedar, Emery County, Utah, one of which was kindly presented to the writer. Other specimens examined, sent by Dr. John W. Sugden, have been, male, June 10, 1934, Orangeville, Emery County, and male, June 15, 1935, Price, Carbon County, Utah. This form which is now regarded as a distinct species was described in 1930, as a "showy black and pale straw-colored insect," and it was further stated that: "Both pairs of wings at base, as well as the anal membranes, are pale straw-colored."

Lately Dr. John W. Sugden, of Salt Lake City, sent me the following species, here described as new.

Okanagana sugdeni, new species.

Type male and allotype female, Orangeville, Emery County, Utah, June 21, 1934. Type in Sugden collection.

This remarkable appearing species has the anal membranes of both pairs of wings blood-red instead of pale straw-color. Also the black tergum has the segments margined posteriorly with dark red instead of straw-color, and the valve of the male is reddish or blackish. Beneath, the pale straw-color areas of *tanneri* are replaced by red. The last abdominal segment of the female is nearly all black, instead of being black at base only.



OKANAGANA SUGDENI

MEASUREMENTS IN MILLIMETERS

	Male Type	Female Allotype
Length of body	29	28
Width of head across eyes	7.5	8
Expanse of fore wings	71	75
Greatest width of fore wing	12	13

NOTE: Since the examination of the type and allotype, Dr. Sugden has sent 15 paratypes collected at Orangeville, Utah, June 10 and 21, 1934. The wings lack the yellowish color of *tanneri,* and are clear and much more transparent. In several the pronotum is black edged all around with reddish.

Okanagana rimosa Say, and the Development of Supernumerary Cross Veins in the Fore Wings.

On July 1, 1937, Dr. A. E. Brower collected four male and fifty-six female specimens of *Okanagana rimosa* Say, in the blueberry

barrens at Aurora, Maine, and kindly sent them to me. It was observed that while they showed hardly any variation in size or color pattern, twelve of the females exhibited variations in the first cross vein, the second cross veins of the fore wings being normal. In three examples, the first cross vein was doubled in both of the fore wings, while the remaining nine had the first cross vein either doubled or forked in but one of the fore wings.

In this JOURNAL for June, 1936, there is a note on the development of a supernumerary vein extending from vein Cu1 into the 8th marginal area of the fore wing in seventy-seven of the three hundred and four specimens of *Okanagana magnifica* Davis, in the writer's collection. The specimens came from Arizona, New Mexico and Colorado.

It is of interest that these variations in the venation of the fore wings should be thus localized in the two species, and it may be added that variation in the cross veins, to some slight extent, is not uncommon.

Okanagana pallidula Davis, Its Distribution and Color Forms.

This species was described and figured in this JOURNAL for December, 1917, from ten males collected in Merced County, California. It was described as: ''A yellowish insect, almost unicolorous, with the membrane or flaps at the base of the wings orange.'' The cicadas were captured while singing, so the supposition that they were immature could not be entertained. In this JOURNAL for 1919, page 187, the insect is said to be: ''Yellowish or yellowish green; front conical and prominent. Expands about 50 mm.'' Sixty-five specimens are recorded in the JOURNAL for March, 1930, collected in 1929 at Bakersfield, Kern County, in Merced County and in Yolo County, California. Dr. R. H. Beamer wrote that they were exceptionally common in 1929 in California's great Central Valley, and as far as has been learned in later years *pallidula* is confined to this valley, occurring from May to August inclusive. All of the specimens examined to 1930 were pale, being either yellowish or pale greenish.

In 1933 Dr. R. H. Beamer of the University of Kansas, sent to me for examination 47 males and 2 females from Mojave, Kern County, California, collected July 7, 1933. In this lot appeared

the first dark colored individuals seen by me, one male being almost black.

In 1936, Mr. F. T. Scott sent 154 *pallidula*, and wrote the cicadas had been quite common in the San Joaquin Valley that year. "It seems to be associated with alkali Mallow and never gets very high off the ground, in fact is rather commonly found in its hole, and may sometimes be lifted out on a straw. Almost half the specimens from this sending were greenish in color when captured, but soon faded." This species has a "very thin light song," and it has been found singing while on the ground with its head out of a hole, as observed by Alonzo C. Davis, in Merced County, July, 1917.

In the lot of 154 sent by Mr. Scott in 1936, there were, from Knight's Landing, Yolo County, a number of pale specimens, a greater number showing some dark color, particularly on the mesonotum, as well as six black males. As this insect was described as pale yellowish or greenish, as indeed most of them are, it would appear, that as there are occasional black specimens, that they should be given a variety name.

Okanagana pallidula Davis. Variety **nigra**, new variety. (Plate XXIV, Fig. 6.)

Type male, Knight's Landing, Yolo County, California, July 20, 1936 (F. T. Scott). Davis collection.

Resembles in size and color many examples of *Okanagana vanduzeei* and *O. consobrina*, but may be separated by the front of the head being more tumid, in lacking the many hairs on the dorsal surface of the head and pronotum, and in the absence of an inner ventral notch on the underside of the female, present in *vanduzeei* and its forms. The front wings are narrower than

MEASUREMENTS IN MILLIMETERS

	Male Type
Length of body	21
Width of head across eyes	6
Expanse of fore wings	51
Greatest width of fore wing	8

in *consobrina.* The pronotum has the hind margin pale and side margins black in the type, but the side margins may also be pale. The basal cell of the fore wings in the type and six of the paratypes is clouded, as in *vanduzeei,* and nearly clear in one, as in the connecting color forms collected at the same place and time.

Though recorded only from Yolo and Kern counties, variety *nigra* should be found elsewhere in the Sacramento and San Joaquin Valley.

PLATE XXIV

Figure 1. *Tibicen marginalis* variety *pronotalis*. Type.
Figure 2. *Diceroprocta alacris* variety *campechensis*. Type.
Figure 3. *Diceroprocta tepicana*. Type.
Figure 4. *Diceroprocta bakeri* (Distant).
Figure 5. *Diceroprocta delicata* variety *aurantiaca*. Type.
Figure 6. *Okanagana pallidula* variety *nigra*. Type.
Figure 7. *Herrera lugubrina* variety *compostelensis*. Type.
Figure 8. *Herrera laticapitata*. Type.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A REVIEW OF THE GENUS CROPHIUS STÅL, WITH DESCRIPTIONS OF THREE NEW SPECIES (HEMIPTERA—HETEROPTERA: LYGÆIDÆ)

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Only three species of *Crophius* were recognized previous to the time E. P. Van Duzee published his monograph of the genus (Bull. Buffalo Soc. Nat. Sci. IX, 1909 (1910), pp. 389–398). That author added four new species from the western part of the United States and correctly assigned to the genus *Mayana costata* and *M. dirupta* Distant and *Oxycarenus scabrosus* Uhler. Since it is now possible to recognize both of Distant's species from Guatemala and since three new forms have been discovered it seems advisable to review the genus. Aside from their arrangement in a revised key, the old species, which were clearly diagnosed by Van Duzee, need no further description. In order that they may be more readily recognizable, I have added a brief characterization of Distant's two species referred to above, based on specimens contained in the collection of the U. S. National Museum. (*Aneuropharus*) *Crophius leucocnemis* Berg, 1879, is omitted from the key, as it is unknown to me.

Nearly all the species before me are represented by fairly long series, extensive enough at least to show that coloration is fairly uniform and characteristic in each species. It wil be noted that both in the key and in the descriptions much reliance is placed upon this factor for distinguishing certain forms which are so closely related that it is difficult otherwise to differentiate them.

Key to Species of Crophius

1. Pronotum anteriorly without a complete or conspicuous, transverse, white or light colored band 2
   Pronotum anteriorly with a complete, conspicuous, transverse, white or light colored band 10
2. Veins of membrane, at least in part, irregular, either branched or reticulated 3

Veins of membrane entirely simple and unbranched 6

3. Head and pronotum with numerous erect grayish hairs in place of glandular hairs; veins of membrane reticulate 4

Head and pronotum nearly glabrous or with short glandular hairs; veins of membrane branched or irregular 5

4. Costal margin of corium impunctate and immaculate; corium closely and coarsely punctate between the fuscous veins .... *diruptus* (Distant)

Costal margin of corium with an irregular row of fuscous punctures; corium sparsely punctate between the concolorous veins. *costatus* (Distant)

5. Veins of membrane piceous, irregularly ramose and broken. Costal margin very slightly expanded, gently, convexly rounded from base to apex. *ramosus* n. sp.

Veins of membrane slightly fuscous, branched apically. Costal margin distinctly expanded and nearly straight from base to apex. *impressus* Van Duzee

6. Costal margin of corium impunctate and immaculate. Membrane with a large fuscous discal area, devoid of small spots between the veins 7

Costal margin of corium spotted with fuscous. Membrane with small fuscous spots between the veins 9

7. Head, pronotum, scutellum, clavus, and inner apical part of corium black. Membrane with a distinct white spot at inner basal part. *schwarzi* Van Duzee

Head, pronotum, and scutellum piceous to dark ferruginous. Membrane without a white basal spot 8

8. Corium whitish, entirely unicolorous. Membrane fuscous, broad apical margin white with a row of fuscous spots .... *heidemanni* Van Duzee

Corium cinereous to testaceous, fusco-punctate, veins frequently infuscated. Wide margin of membrane hyaline, immaculate. *disconotus* (Say)

9. Membrane short, less than half as long as corium, hemielytra strongly convex; costal margin strongly convex from base to apex. Commissure nearly twice as long as scutellum .... *convexus* n. sp.

Membrane about as long as corium, hemielytra only moderately convex; costal margin slightly convex from base to apex. Commissure about as long as scutellum .... *scabrosus* (Uhler)

10. Pronotum as long as wide. Veins of membrane, at least towards apex, branched. Head ferruginous .... *angustatus* Van Duzee

Pronotum distinctly wider than long. Veins of membrane simple, unbranched. Head black or piceous 11

11. Entire corium unicolorous, white, disk sparsely and faintly punctate; veins scarcely elevated. Membrane hyaline with uncolored veins . *albidus* n. sp.

Corium sordid white to gray, disk distinctly punctate with fuscous; veins distinctly elevated, infuscated. Membrane hyaline with slightly infuscated veins .... *bohemani* (Stål)

Crophius ramosus new species

The following parts are dull black: Head, basal segment of antenna, anterior lobe of pronotum except mesally at anterior margin, where it is obscurely pale, scutellum, outer apical angle of corium, and ventral surface except bucculæ, margins of acetabula, and posterior margins of metapleura, which are white. Posterior lobe of pronotum sordid cinereous or lightly infuscated, with an indistinct median pale line. Corium cinereous, punctate with fuscous and clouded with fuscous especially along posterior margin and also frequently along the veins. Membrane sordid white, opaque, with veins and irregular intervening maculæ heavily infuscated. Apical three segments of antennæ, rostrum, femora, tibiæ at bases, and apices and terminal segments of tarsi dark castaneous. Dorsal parts, particularly the head, anterior lobe of pronotum, and the scutellum clothed with short glandular hairs, thus appearing sabulose.

Head about as wide as long, the short glandular hairs proclinate. Antenna with the basal segment somewhat incrassate and slightly exceeding the tylus, terminal segment but slightly longer than second. Pronotum about one-fourth wider than long, the impression between the two lobes shallow, anterior submargin and posterior lobe, except on the middle line, coarsely punctate with fuscous. Scutellum strongly, transversely depressed at base, glabrous medially. Corium with costal margin slightly expanded, with a single irregular row of small fuscous punctures; the extreme edge nearly straight in the male, gently rounded from base to apex in the female; surface coarsely punctate between the veins, punctures usually more confluent along the veins, which are distinctly elevated; posterior margin before the membrane fringed with short glandular hairs. Membrane with irregular veins which are often incomplete and broken, interspersed with small fuscous spots. Length 2.50–3.00 mm.

Type, male: Snowville, Utah, June 24, 1932, on *Atriplex* (G. F. Knowlton). Paratypes, males: Hollister, Idaho, June 5, 1931, on *Norta altissima,* and Sept. 26, 1932; Hubbs Butte, Idaho, June 8 and 15, 1931; 2 Burley, Idaho, June 16, 1931; Hansen, Idaho, June 23, 1931. Females: Jerome, Idaho, May 29, 1931; Hubbs Butte, Idaho, June 8 and 17, 1931; Burley, Idaho, June 9 and 16 and July 24, 1931; Hansen, Idaho, June 9 and 16, 1931; Hollister, Idaho, June 13, 1931, on *Norta altissima.* U. S. National Museum Cat. No. 52163.

Most of the Idaho specimens were taken in wind-vane traps by David E. Fox.

Crophius ramosus is most closely related to *C. scabrosus* Uhler but is readily distinguished from that species by the sebaceous character of the pubescence and by the strikingly different venation of the membrane. One male specimen from Burley, Idaho,

differs from the typical form in having the tylus and basal two segments of the antenna ferruginous.

Crophius albidus new species

Nearly glabrous, somewhat shining. Head black. Pronotum with the anterior lobe behind the broad, white, anterior margin, the posterior lobe broadly on either side of the middle, and the scutellum fuscocastaneous. Antenna with the first three segments and also the rostrum ferruginous, terminal segment of the former lightly infuscated. Wide anterior margin and a subtriangular, mesal spot on posterior part of the pronotum and the immaculate corium white. Membrane hyaline, with veins either uncolored or very faintly infuscated. Ventral surface fuscocastaneous, with the following parts white: Anterior margin of the prosternum, margins of the acetabula, and posterior margins of the metapleura. Femora and bases of tibiæ castaneous, the latter elsewhere white.

Head as long as wide, closely punctate. Antenna with the basal segment slightly incrassate, extending by a third of its length beyond apex of head, second and fourth segments nearly equal. Pronotum one-third wider than long, transverse impression between the lobes shallow, disk of anterior lobe impunctate, anterior submargin and posterior lobe closely and coarsely punctate. Scutellum a little wider than long, finely, sparsely punctate either side of the middle. Corium and clavus ivory white, immaculate, with concolorous, shallow punctures; more closely punctate on the clavus; veins of corium inconspicuous; costal margin distinctly expanded and slightly reflexed, the extreme edge straight anteriorly. Membrane hyaline, with simple, inconspicuous veins. Length 3.00–3.50 mm.

Type, male: Ephraim, Utah, June 15, 1904. Paratypes, males: 3, Mt. Pleasant, Utah, June 11, 1903. Females: With the same data as male paratypes. U. S. National Museum Cat. No. 52164.

Crophius albidus is most closely related to *C. bohemani* (Stål) and *C. disconotus* (Say), from both of which it differs by its immaculate and unicolorous corium as well as by the very slightly infuscated or concolorous veins of the membrane.

Crophius convexus new species

Dull, sparsely clothed with short glandular hairs, more numerous on the head and pronotum. Strongly convex, especially across the hemielytra. Sordid gray. The following parts black to fuscocastaneous: Sides of head, basal and terminal segments of antenna, base of scutellum, and ventral surface, with the exception of posterior margins of metapleura, which are white, and margins of the acetabula, which are sordid testaceous; broad central disk of head and second and third segments of antenna ferruginous; anterior lobe of pronotum across the cicatrices castaneous, surface before and behind these as well as

the scutellum posteriorly sordid testaceous, punctate with fuscous; a pale, testaceous, longitudinal, median line of the pronotum is interrupted by the cicatrices; clavus and corium, except for the paler basal fourth of each, profusely punctate with fuscous, with the veins often infuscated; the expanded costal margin with an irregular row of distinct fuscous punctures; membrane semihyaline with the veins and small spots, fuscous; legs with the femora, except at apices and the tibiæ narrowly at bases and apices, castaneous, the latter elsewhere white.

Head a little wider than long, coarsely and roughly punctate; clothed with short glandular hairs, more numerous about the eyes and along the preocular margins. Antenna with the incrassate basal segment extended by a third of its length beyond the tylus. Pronotum about one-third wider than long, region of the cicatrices distinctly elevated and sparsely punctate, elsewhere rather closely and coarsely punctate except along a narrow pale median calloused line; posterior lobe but little wider than the anterior lobe, the shallow impression between the lobes usually more distinct at the side margins. Scutellum about one-third wider than long, sparsely, coarsely punctate. Hemielytra strongly convex, lateral margins convexly rounded throughout; inner margins behind scutellum straight and in contact to base of membrane, the commissure distinctly longer than the scutellum, one membrane only slightly overlapping the other; clavus not declivous but level with the corium, coarsely irregularly punctate; corium with two well marked veins; surface coarsely and closely punctate; costal margin distinctly expanded and irregularly punctate with fuscous. Membrane short, less than half as long as corium, wrinkled; veins distinctly elevated, unbranched; numerous small dots between the veins. Length 2.50–3.00 mm.

Type, male: Peru, on *Cereus,* intercepted at the Inspection House, Bureau of Entomology and Plant Quarantine, Washington, D. C., Aug. 4, 1936. Paratypes: 5 males and 8 females, 6 of the latter with the same data as the type; 1 with the same data as the type but intercepted June 4, 1936, and 1 labeled Callas, Peru, on *Cereus,* intercepted June 3, 1936. U. S. National Museum Cat. No. 52165.

Crophius convexus is most closely related to *C. scabrosus* (Uhler) and *C. ramosus,* n. sp., having short glandular hairs, particularly on the head, but differs markedly in being more ovate and more convex dorsally and in having a much shorter membrane. The shape of the pronotum and the character of the hemielytra as well as the aborted wings indicate very clearly that all of the specimens at hand are brachypterous. So far as known and recorded this apears to be the only case of brachyptery occurring in the genus *Crophius.*

Crophius diruptus (Distant)

Mayana dirupta Distant, Biol. Cent.-Amer., Rynch. II, 1893, 388.

This species agrees with *costatus* in the pilosity of the head and pronotum and in the reticulate-veined membrane but differs from that species in being somewhat shining and in having a much more closely and coarsely punctate clavus and corium, with slightly expanded costal margin impunctate.

A single male specimen labeled *Mayana dirupta* from the Biologia Centrali-Americana material, from the type locality, is in the collection of the U. S. National Museum.

Crophius costatus (Distant)

Mayana costata Distant, Biol. Centr.-Amer., Rynch. II, 1893, 388, Tab. XXXIV, fig. 13.

Closely related to *Crophius scabrosus* Uhler, which it resembles in appearance, but differs from that species in the following important respects: Head and pronotum distinct pilose, not provided with short, glandular hairs, the corium more sparsely punctate with fuscous and the veins of the unspotted membrane distinctly reticulated. This latter characteristic is plainly indicated in Distant's figure of a specimen from Guatemala, but is not mentioned in the description. The above characterization is based on two specimens, ♂ and ♀, from Mexico determined by me in the collection of the U. S. National Museum. These were intercepted at Brownsville, Texas, October, 1936, on chrysanthemums. If I am correct in my identification of this species there is one discrepancy which should be noted. Although the figure shows the costal margin distinctly punctate or spotted with fuscous, the description states that this margin is impunctate. The two specimens before me have the costal margin agreeing with the figure.

List of the Species of Crophius

albidus n. sp.—Utah.

angustatus Van Duzee, Bull. Buff. Soc. Nat. Sci. IX, 1909 (1910), 391, 395, fig.—Calif., Utah.

bohemani (Stål), Freg. Eugen. Resa, Ins., Hem., 1859, 251.—Calif., Oreg., Wash., Vancouver Is., Idaho, Utah.

convexus n. sp.—Peru.

costalis (Distant), Biol. Centr.-Amer., Rynch. II, 1893, 388, Tab. XXXIV, fig. 13.—Guatemala, Mexico.

diruptus (Distant), Biol. Centr.-Amer., Rynch. II, 1893, 388. —Guatemala.

disconotus (Say), Heterop. N. Harm. Ind. 1832, 14.—Canada and eastern part of U. S.

heidemanni Van Duzee, Bull. Buff. Soc. Nat. Sci. IX, 1909 (1910), 391, 393, fig.—Ariz.

impressus Van Duzee, Bull. Buff. Soc. Nat. Sci. IX, 1909 (1910), 391, 396, fig.—Calif.

leucocnemis (Berg), Hem. Argent. 1879, 285.—Argentina.

ramosus n. sp.—Idaho, Utah.

scabrosus (Uhler), Proc. U. S. Nat. Mus. XXVII, 1904, 353.— Ariz., N. Mex., Utah, Nev., Colo., Idaho, western Nebr.

schwarzi Van Duzee, Bull. Buff. Soc. Nat. Sci. IX, 1909 (1910), 391, 392, fig.—Ariz.

PERSISTENCE OF TORTILIA VIATRIX BUSCK

On September 18, 1933 a representative of a warehouse at Hoboken, New Jersey brought to the attention of the Bureau of Entomology and Plant Quarantine a moth which was present in large numbers in bagged senna leaves (about 645,000 pounds) imported from Sudan, Africa some one and one-half to three years previous.[1] The insect was described by Busck as *Tortilia viatrix*.[2] Arrangements were made for fumigation of this senna, and on November 17, 1933 this was accomplished using "Carboxide" (ethylene oxide-carbon dioxide mixture). The gas was used at the rate of 15 pounds of carboxide to 1,000 cubic feet of space. The length of exposure was 48 hours. Some few adult moths were present, though larvæ and eggs predominated. Twenty-two vials containing live insects were placed in various places throughout the baled senna, and all the check insects were killed. An inspection in August of 1934 revealed that there were many of the insects in the senna, though the fumigation had reduced the number considerably. On September 15, 1934 the senna was again fumigated with hydrocyanic acid gas, used at the heavy dosage of 2 pounds of sodium cyanide per 1,000 cubic feet of space. The exposure was for 25 hours. Again no sign of life was observed in the check vials. Since that time however the infestation has continued, adults being found in 1935, 1936, 1937 and 1938. The leaves are dry at this time to the point of brittleness, and the warehouse in which the material is stored is bone dry. Yet the infestation is continuing. It was Doctor Busck's opinion that "the continued survival and spread of this species in America is not probable, though not necessarily excluded." He realized that since the insect had been able to maintain itself for several generations in the warehouse, climatic conditions would not be the determining factor in its survival. We agree with Doctor Busck that if the species finally disappears from America it will be due to the absence of stored senna and because it is not able to survive on our native Cassia, in the open.—F. A. Soraci.

[1] Weiss, H. B., Rex, E. G. Outbreak of an African Moth in Stored Senna. Jour. Econ. Ent., vol. 27, No. 3, p. 557–558.

[2] Proc. Ent. Soc. Wash., vol. 36, No. 3, March, 1934.

THOMAS MARTYN'S "ENGLISH ENTOMOLOGIST"

By Harry B. Weiss

About twelve years ago I wrote an account entitled "Thomas Martyn, Conchologist, Entomologist and Pamphleteer of the Eighteenth Century," that was published in "The American Collector" (Vol. 3, No. 2, November 1926, p. 57–62, 2 pl.). Recently I acquired a copy of "The English Entomologist" by Martyn and a leisurely examination of it has brought some interesting facts to light.

Little is known of Thomas Martyn except what may be gleaned from an examination of his publications. Apparently he flourished from about 1760 to 1816. Supposedly a native of Coventry, in 1784 he was living at 26 King Street, Covent Garden, and in 1786 at 10 Great Marlborough Street, London. At this latter address he ran his "private painting establishment for instructing youths," and by 1789 he had ten scholars or apprentices. These boys, under his training, made drawings of shells, etc., and colored the plates for his books. In 1804 he was located at 52 Great Russell street, Bloomsbury.

During his lifetime, Martyn received flattering letters, and medals from kings and emperors testifying to the excellence of his work and in his books these are usually mentioned in the introductory portions. When it came to collecting honors, Mr. Martyn knew his way around. For example, he dedicated "The English Entomologist" to Charles IV, King of Spain, and this was arranged through the Spanish ambassador to the English court, the Marquis del Campo. However, Martyn's works were excellently printed and engraved and deserved princely recognition, even though it was stimulated. As these matters are more specifically mentioned in my previous account there is no need of repeating them here.

Some of Martyn's works are bibliographical puzzles. For example, Mr. W. H. Dall many years ago stated that bibliographers had been unfortunate in their references concerning the publication dates of Martyn's most important work, "The Universal

Conchologist exhibiting the Figure of every known Shell accurately drawn and painted after Nature; with a new Systematic arrangement by the Author,'' presumably published in 1784. As a matter of fact, the first 80 plates were published in 1784; forty more appeared in 1786, and the entire work of 160 plates was completed in 1787. Dates on title pages were changed at least twice and copies are known to exist dated 1784, 1787, and 1789.

In 1797 he brought out ''Psyche, Figures of Non descript Lepidopterous Insects, or Rare Moths and Butterflies From different parts of the World.'' C. Davies Sherborn in ''A Note on Thomas Martyn's 'Psyche,' 1797'' (Ann. Mag. Nat. His. (7) 1, 1898, p. 106–108) gave collations of the ten copies then thought to be in existence. However, in 1931 Francis J. Griffin and C. Davies Sherborn published an article entitled ''A Census of the Known Copies of 'Martyn (T.) Psyche,' 1797'' in the June issue of ''The Library Association Record'' (Vol. 1, Ser. 3, No. 6, p. 192–6), and in this the subject is reopened and seventeen copies, in varying stages of completion are located and collated. These authors traced 8 copies with 32 plates and no text; 1 copy with 31 plates and no text; 1 copy with 28 (+ 4 in facsimile) plates and no text; 1 copy with 15 plates and no text; 1 copy with 13 plates and no text; 2 copies with 4 plates and 8 pages of English and 8 pages of French text; and 3 copies with 2 plates and 6 pages of English and 6 pages of French text.

Martyn's work entitled ''The English Entomologist Exhibiting all the Coleopterous Insects Found in England: Including upwards of 500 different Species, the Figures of which have never before been given to the Public The Whole Accurately drawn & painted after Nature, Arranged and named according to the Linnean System'' was published in London in 1792 according to the engraved title page. The dedication to Charles IV, King of Spain, and the Indies, is dated March 21, 1793 and the paper and plates in some instances, carry 1801 watermarks. Although watermark dates cannot always be relied upon, it does not seem as if this book actually appeared in 1792. The title page was probably engraved in 1792 and used later when the forty-two plates were finished. This no doubt took place between 1793 and 1801.

Although nine years seems a long time between the actual engraving of the title page and the appearance of the finished volume, it is conceivable that delays occurred either in the preparation of the plates or in the accumulation of printing funds.

On the other hand, the 1801 signatures may have been printed in 1801 and bound with signatures printed previously. Without more information on what actually happened, it is difficult to arrive at a satisfactory explanation of the discrepancies in the dates.

Martyn's natural history books were finely printed and there was nothing cheap about them. In fact "The English Entomologist" bears the imprint of the "Shakspeare Press, W. Bulmer & Co." This press, which had the support and interest of George III was established about 1787. The firm was known as W. Bulmer and Co. and included Mr. George Nicol, bookseller to the King, and Mr. William Martin, type designer. In 1819 Mr. Bulmer retired, with a well-earned fortune. The Shakspeare Press was a commercial firm that combined printing, type founding, engraving and paper to produce as nearly a perfect product as possible. The best paper, the best types and the best ink were chosen by Bulmer, who was always searching for improvements, and his books show the care and thought that went into their production. This was unusual for commercial printers of that time and only one other printer (Thomas Bensley) had similar ideals. Whatman paper was used and in Martyn's "English Entomologist" the watermarks "J. Whatman" and "J. Whatman 1801" may be found. This is true also for Martyn's "Universal Conchologist, although the copy (1789) of this examined at the library of the American Museum of Natural History does not mention the name of the printer. The Whatman mill, long noted for the superiority of its paper was established in Maidstone, England in 1731 by James Whatman and the James Whatman Springfield mill is in existence today at Maidstone, Kent.

Martin's fount used by Bulmer has individuality and beauty and it lent itself to the production of large, imposing books. This may be readily noted by an examination of the text of "The English Entomologist," which is in both English and French.

Entomologically, the contents of "The English Entomologist"

are now chiefly of historical value, although at the time of its publication it must have been of considerable interest to Coleopterists who had need of identifying their captures. How well they succeeded is problematical. Accompanying the 42 plates containing illustrations of over 500 species is the text from Linnaeus' "Systema Naturae," giving the characters of 30 "genera," now families, including the Forficulidæ, then considered as beetles. In the Staphylinidæ, Carabidæ and Curculionidæ quite a few unnamed species are figured. Most of the drawings were made from specimens in Martyn's collection and are well executed and colored. However, he did not favor enlarged representation and consequently all illustrations show the beetles in their natural size, resulting in many figures being so small that they are impossible of accurate delineation or identification. Many, because of their smallness, are meaningless.

Martyn intended to illustrate the Hemiptera, Neuroptera, Hymenoptera and Diptera in a similar way in two volumes, but so far as is known, they never materialized.

In addition to painting and natural history, Martyn had other interests which are indicated by some of the following titles of his works.

1. "Hints of important Uses to be derived from Aerostatic Globes. With a Print of an Aerostatic Globe . . . originally designed in 1783." London, 1784.
2. "The Universal Conchologist. . . ." London, 1784.
3. "The Soldiers and Sailors Friend," London, 1786.
   This is an 8vo pamphlet suggesting a national assessment for the maintenance of superannuated disabled soldiers and sailors.
4. "A Short Account of the Nature, Principle and Progress of a Private Establishment. . . ." London, 1789.
   This is an account of his "Academy of Painting."
5. "The English Entomologist. . . ." London, 1792 (?).
6. "Aranei, or a Natural History of Spiders. . . ." London, 1793.
7. "Figures of Plants," London, 1795.
8. "Psyche, Figures of Non descript Lepidopterous Insects. . . ." London, 1797.

9. "A Dive into Buonaparte's Councils on his projected Invasion of old England." London, 1804.
10. "Great Britain's Jubilee Monitor and Briton's Mirror . . . of their most sacred Majesties George III and Charlotte his Queen." London, 1810.

    This is a pamphlet commemorating the 50th year of the King's reign.

    Thomas Martyn also edited in 1811, the "Natural System of Colours . . . by the late Moses Harris."

From the standpoint of the history of printing, Martyn's books are of unusual interest and they also have their place in the history of natural history.

OCCURRENCE OF A SAWFLY (ACANTHOLYDA ERYTHROCEPHALA L.) IN NEW JERSEY

In mid-June of 1937, a nursery inspector of the New Jersey Department of Agriculture, Mr. C. E. Cobb, noted defoliation of several acres of 5 to 12 foot red and Austrian pines (*Pinus resinosa, P. nigra*) in a nursery at Franklin Lakes (Oakland), New Jersey. Some few larvæ were taken and these were identified at the New Jersey Agricultural Experiment Station as *Itycorsia zappei* Rohw. A note of the occurrence of this insect was forwarded to the Insect Pest Survey of the Bureau of Entomology and Plant Quarantine, appearing in the Insect Pest Survey Bulletin, vol. 17, No. 7, September 1, 1937. In observing the insect the writer was puzzled by the fact that the larvæ had completed their growth and were entering the soil at least a month before *Itycorsia zappei* is known to enter the soil. Accordingly, the writer pointed out the infestation to entomologists of the Division of Forest Insects Laboratory at Morristown, New Jersey. They, in turn, pointed out a 40 foot white pine (*Pinus strobus*) at Convent Station (Morristown), New Jersey which they had been keeping under observation and which seemed to be similarly infested. Larvæ were taken from both sites, reared to adults and kindly identified by G. A. Sandhouse in April, 1938 as *Acantholyda erythrocephala* (L.), an insect which had been taken in the United States only once before. On May 7, 1925 F. F. Smith and A. B. Wells took two specimens, both males, from a nursery at Chestnut Hill, Pennsylvania.[1]

On June 1 of 1938 at which time the larvæ of this insect were feeding on the needles of the pines, a spray of lead arsenate was applied from an autogiro to the Oakland infestation. Practically 100 per cent kill was obtained. Since that time, however, the insect has been taken in many locations in the State, as far south as New Brunswick, and as far north as the northern-most corner of the State. Larvæ have also been taken as far west as Flemington and as far east as Alpine in New Jersey. No more serious infestations have been discovered, but it does appear that the insect is widely distributed in this State.—F. A. Soraci.

[1] Rohwer, S. A. Jour. Wash. Acad. Sci. 17 (7), 173–174. 1927.

RECORDS AND DESCRIPTIONS OF NEOTROPICAL CRANE–FLIES (TIPULIDÆ, DIPTERA), X

By Charles P. Alexander
Amherst, Massachusett

The preceding part under this general title was published in June, 1931 (Journal of the New York Entomological Society, 39: 109–122). The crane-flies discussed herewith were all taken in Colombia by Mr. Philip C. Stone, Graduate Student in Entomology at the Massachusetts State College. The various species were taken at and near Bogota, altitude 8,000 feet; at Usme, 25 kilos south of Bogota, altitude 10,000 feet; and at Fusagasuga, altitude 4,800 feet. The types of the novelties are preserved in my collection through the kindness of the collector, to whom my very sincere thanks are extended.

Genus *Tipula* Linnæus

Tipula bogotana new species.

Belongs to the *monilifera* group; antennæ (male) unusually short, only one-half the length of the body; flagellum dark brown, the basal swellings black; wings with a strong brown tinge, with very restricted whitish areas on disk, including an oblique band beyond anterior cord; male hypopygium with the inner dististyle a broadly compressed pale blade; eighth sternite with a very long slender median lobe.

Male.—Length about 13–15 mm.; wing 15–17 mm.; antenna 7–7.5 mm.

Frontal prolongation of head obscure yellow, including the long nasus; palpi black. Antennæ (male) relatively short for a member of this group, as shown by the measurements; scape and pedicel yellow, flagellar segments dark brown, the globular basal enlargements black; outer flagellar segments more uniformly blackened. Head buffy-brown, variegated with dark brown, including a median line and more lateral areas on posterior vertex.

Pronotum buffy-brown, with a narrow dark brown median line. Mesonotal præscutum buffy-brown with four distinct but narrow dark brown stripes; interspaces with very conspicuous dark brown setigerous punctures; a sublateral darkening on præscutum between the lateral stripes and the margin of the sclerite; scutal lobes gray, each variegated by two slightly darker brown areas; scutellum brownish gray, with a capillary median brown vitta; mediotergite gray, the posterior portion more darkened on either side, the posterior half of the sclerite with several brown setigerous punctures. Pleura and pleurotergite almost uniformly buffy. Halteres long, stem brown,

the base narrowly yellow, the knobs dark brown. Legs with the coxæ buffy; trochanters yellow; femora and tibiæ brown, the tips narrowly and insensibly darker; tarsi black. Wings relatively broad, with a strong brown tinge, the prearcular and costal portions, together with the stigma, darker brown; very restricted whitish areas on disk, including an oblique band beyond anterior cord, small areas near outer ends of cells *R* and *M*, and paired pale spots in cell *Cu* before midlength; a zigzag pale area at about midlength of cell *1st A;* basal portion of cell *2nd A* somewhat pale.

Abdominal tergites reddish brown, slightly darkened medially and more heavily and distinctly sublaterally, the extreme margins pale; subterminal segments more uniformly darkened; hypopygium chiefly pale. Male hypopygium with the inner dististyle a broadly compressed, pale blade, only slightly more narrowed on basal portion. Eighth sternite with a very long slender median lobe, this fully five times as long as the width at base.

Holotype, ♂, Bogota, altitude 8000 feet, July 1, 1936 (Stone). Paratopotypes, 6 ♂♂, July 6–August 15, 1936 (Stone).

The nearest ally of the present fly is *Tipula carizona* Alexander, likewise from the Colombian Andes. This latter species differs in the longer antennæ of the male and in the distinct details of structure of the male hypopygium, especially the inner dististyle and the short broad lobe of the eighth sternite. The wing-pattern is somewhat similar in the two flies, but with the white band before the cord even more restricted in *bogotana* and with the cubital and anal cells differently patterned.

Tipula multimoda new species.

MALE.—Length about 15 mm.; wing 13 mm.; antenna 7 mm.

Very closely allied to *Tipula spinicauda* Alexander (JOURNAL NEW YORK ENTOMOLOGICAL SOCIETY, 27: 152–153; 1919) of Panama, differing especially in the details of structure of the male hypopygium.

Male hypopygium with the lateral arms of the ninth tergite shorter and broader, suddenly narrowed at tips, with spines almost to extreme apex. Bilobed appendange in membrane between the eighth and ninth sternites much better developed and more complicated than in *spinicauda,* each lobe bearing a powerful dorsally-directed arm, densely covered with short pale setæ and pubescence, these arms apparently asymmetrical on the two lobes of the appendage.

Holotype, ♂, Puerto Boyaca, Magdalena Basin, altitude 500 feet, August 16, 1936 (Stone).

Genus *Limonia* Meigen

Limonia (Rhipidia) stonei new species.

Size large (wing, female, 11 mm.); antennæ black, the apical pedicels of the segments brownish yellow; flagellar segments rather strongly produced;

mesonotal præscutum obscure yellow, with three darker brown stripes; scutum and scutellum dark brown, with a continuous median testaceous yellow stripe; mediotergite uniformly dark brown; pleura brownish yellow, striped longitudinally with darker; halteres obscure yellow, the base of knob darkened; femora obscure yellow, the tips narrowly blackened, tibiæ and tarsi brownish black to black; wings cream-yellow, heavily patterned with darker, including a series of six major costal areas; disk of wing streaked longitudinally with brown; *Sc* long, Sc_1 extending to beyond midlength of *Rs; m-cu* at fork of *M;* abdominal tergites brownish black to black; sternites yellow, the caudal margins narrowly blackened.

FEMALE.—Length about 10 mm.; wing 11 mm.

Rostrum and palpi black. Antennæ black, the apical pedicels of the flagellar segments brownish yellow; segments rather strongly produced (for the female sex), the longest serrations being about as long as the segments; verticils of unusual length, on the more basal flagellar segments about one-half longer than the segments. Head dark gray, the vertex more infuscated in front; anterior vertex reduced to a narrow strip that is only about one-half the diameter of the scape.

Pronotum brown. Mesonotal præscutum obscure brownish yellow, with three broad, darker brown stripes; anterior ends of lateral stripes a little incurved, interrupting or restricting the narrow interspaces at this point; lateral margins of præscutum behind the humeri a little darkened; median area of scutum and scutellum broadly testaceous-yellow, the lateral portions abruptly dark brown; mediotergite dark brown. Pleura brownish yellow, conspicuously variegated by darker, including a relatively wide blackish stripe extending from the cervical region, crossing the propleura, anepisternum, dorsal pteropleurite and ventral pleurotergite to base of abdomen; a more ventral pleural stripe includes the bases of the fore and middle coxæ and the ventral sternopleurite. Halteres obscure yellow, the base of knob darkened. Legs with the coxæ darkened basally, the posterior pair least so, the remainder obscure yellow; trochanters yellow; femora obscure yellow, the tips narrowly but conspicuously blackened, the amount subequal on all legs; tibiæ and tarsi brownish black to black. Wings with the ground-color cream-yellow, heavily and conspicuously patterned with dark and lighter brown; the darker color includes a series of six major costal areas, the basal three confluent or nearly so, greatly restricting the interspaces before origin of *Rs;* fourth area oval, at fork of *Sc;* fifth area stigmal, confluent with a conspicuous seam along cord; last costal area shortly before outer end of cell R_2; most of remaining wing-surface seamed and washed with darker, chiefly restricting the yellow ground-color to longitudinal streaks in the centers of the cells; bases of anal cells broadly yellow; veins dark. Venation: *Sc* relatively long, Sc_1 ending beyond midlength of *Rs*, Sc_2 longer than Sc_1; free tip of Sc_2 lying shortly beyond level of R_2, R_{1+2} jutting beyond this point as a short spur; *m-cu* at fork of *M*.

Abdominal tergites brownish black to black, the basal segment a little brightened laterally; sternites yellow, the caudal margins narrowly black-

ened. Ovipositor with the genital shield blackened; valves yellowish, darkened at bases.

Holotype, ♀, Usme, altitude 10,000 feet, July 8, 1936 (Stone).

I take unusual pleasure in dedicating this species to my friend, Mr. Philip Carlton Stone. This large and very conspicuous fly needs no comparison with any described species of *Rhipidia*. The wing-pattern is quite different from that of other Neotropical members of the subgenus, somewhat more suggesting certain heavily patterned species of the subgenus *Limonia*.

Limonia (Geranomyia) laudanda new species.

Size large (wing, female, over 11 mm.); general coloration gray, the præscutum with three narrow blackish stripes; halteres with stem yellow, knob brownish black; femora obscure yellow, with a narrow blackened subterminal ring; wings whitish subhyaline, heavily patterned with brown, including five costal areas all of which attain the costal vein; third area including both the fork of *Sc* and origin of *Rs;* cell *1st* M_2 relatively long, about equal in length to vein M_{1+2} beyond it; abdomen black.

FEMALE.—Length, excluding rostrum, about 7.5–8 mm.; wing 11.5–12 mm.; rostrum about 4.2 mm.

Rostrum relatively long, black, the outer ends of the slender labial palpi pale; maxillary palpi black. Antennæ black throughout; flagellar segments cylindrical, with verticils that are shorter than the segments. Head dark gray, the posterior vertex more blackened on either side of the median line.

Pronotum gray, with a blackened median line. Mesothorax gray; præscutum with three narrow blackish stripes that are about as wide as the interspaces, the median one not reaching the suture, the laterals crossing the suture onto the mesal and cephalic portions of the scutal lobes; præscutum dusky near the lateral portions behind the obscure yellow humeral region; median region of scutum and the scutellum more testaceous; mediotergite paler on sides. Pleura dark gray, indistinctly variegated with darker on the ventral anepisternum and ventral sternopleurite. Halteres relatively long, the stem yellow, the knob brownish black. Legs with the fore coxæ brownish gray, paler apically, the remaining coxæ more testaceous yellow; trochanters yellow; femora obscure yellow, with a relatively narrow (0.8 mm.) blackened ring before the still narrower yellow tip; tibiæ brownish yellow, the tips narrowly blackened; basitarsi brown, remainder of tarsi black. Wings whitish subhyaline, the costal interspaces more yellowish; a relatively heavy brown pattern, including five costal areas, all of which reach the costal vein; third area largest, involving both the fork of *Sc* and origin of *Rs;* proximal end of stigmal area more diffuse; fifth area at end of vein R_3; cord and outer end of cell *1st* M_2 conspicuously seamed with brown; tips of veins M_3 to *2nd A*, inclusive, with dusky clouds, larger and more conspicuous on the anal veins; several of the longitudinal veins, including R_{4+5}, *M* and *Cu*, seamed

with dusky; axillary region of cell *2nd A* whitened, the central portion dusky; veins yellow, darkened in the infuscated areas. Venation: *Sc* relatively short, Sc_1 ending opposite or before one-third the length of *Rs*, Sc_2 near its tip; a supernumerary crossvein in cell *Sc;* free tip of Sc_2 and R_2 virtually in transverse alignment; cell *1st* M_2 about equal in length to vein M_{1+2} beyond it; *m-cu* at fork of *M*.

Abdomen black. Ovipositor with the nearly straight valves horn-yellow.

Holotype, ♀, Usme, altitude 10,000 feet, July 8, 1936 (Stone). Paratopotype, ♀, July 7, 1936.

The only regional species that at all resemble the present fly are *Limonia* (*Geranomyia*) *gaudens* (Alexander) of Argentina and *L.* (*G.*) *townsendi* (Alexander) of Peru, both of which are of about the same size but differ conspicuously in the coloration of the body and wings. In both of these species, vein *Sc* is long, with the dark area at its fork entirely disconnected from the one at origin of *Rs*.

Genus *Shannonomyia* Alexander

Shannonomyia bogotensis new species.

General coloration gray, with a narrow blackish median line on head, pronotum and praescutum, reaching the suture as a point; halteres elongate, pale yellow; legs black; wings whitish subhyaline, the prearcular region and cell *Sc* a trifle more yellowish; stigma oval, brown; very restricted dark seams at origin of *Rs*, along cord and at outer end of cell *1st* M_2; vein *Cu* vaguely seamed with darker; *Rs* relatively long, weakly spurred at origin; cell *1st* M_2 elongate, about equal to the longest veins beyond it, with *m-cu* at near two-thirds its length; abdomen, including hypopygium, brownish black.

MALE.—Length about 6.5 mm.; wing 8.3 mm.

Rostrum and palpi black. Antennae with scape and pedicel black; flagellum broken. Head gray, the posterior vertex with a narrow blackish median longitudinal line.

Pronotum gray, with a capillary blackish longitudinal stripe. Mesonotum ashy-gray, the praescutum with a single median brownish black stripe, narrower and more distinct in front, becoming more diffuse and narrowed behind, reaching the suture as a point. Pleura gray. Halteres elongate, pale yellow. Legs with the coxæ gray; trochanters brownish yellow; remainder of legs black, the femoral bases restrictedly a little paler. Wings whitish subhyaline, the prearcular region and cell *Sc* a trifle more yellowish; stigma oval, brown; very restricted dark seams at origin of *Rs*, along cord and at outer end of cell *1st* M_2; vein *Cu* vaguely seamed with darker; axillary region restrictedly darkened; veins brown, more luteous in the yellow areas. Venation: *Sc* relatively long, Sc_1 ending shortly before fork of *Rs*, Sc_2 close to its tip; *Rs* relatively long, about equal in length to cell *1st* M_2, angulated to weakly spurred at origin; R_2, R_{2+3} and R_{1+2} all subequal; R_3 about equal to vein R_{2+3+4}; cell *1st*

M_2 elongate, about as long as vein M_{1+2} beyond it; *m-cu* lying unusually far distad, at near two-thirds the length of the cell.

Abdomen dark brown to brownish black, sparsely pruinose; hypopygium brownish black.

Holotype, ♂, Usme, altitude 10,000 feet, July 9, 1936 (Stone).

Shannonomyia bogotensis is very different from the other regional species of the genus in the gray coloration, pattern of the head and praescutum, black legs, pattern of wings, and the venation, especially the long cell *1st* M_2, with *m–cu* lying far distad. There is no close ally known to me.

Genus *Polymera* Wiedemann

Polymera (Polymera) sordidipes new species.

Size large (wing, male, 8 mm. or more); general coloration brown, the pleura more yellowish; antennae nearly twice as long as body, the flagellum uniformly blackened, the segments nearly cylindrical; legs brown to brownish black, the tarsi dark, only the posterior pair more yellowish brown; wings uniformly tinged with yellow; veins brownish black; *Rs*, R_{2+3+4} and R_{1+2} subequal; *m-cu* at from one-third to one-half its length beyond the fork of *M*.

MALE.—Length about 7–7.5 mm.; wing 8–9 mm.; antenna about 13–14 mm.

FEMALE.—Length about 8.5–9 mm.; wing 9–10 mm.

Rostrum testaceous; palpi brown. Antennæ (male) nearly twice as long as body; scape and pedicel yellow, flagellum uniformly blackened; flagellar segments nearly cylindrical, the enlargements only feebly indicated; elongate verticils distributed throughout the length of the segments, with shorter setæ interspersed. Head brown.

Mesonotum uniformly brown, the pleura more yellowish, unmarked. Halteres infuscated, the base of stem restrictedly pale, the knob somewhat darker. Legs with the coxæ and trochanters obscure yellow; remainder of legs brown to brownish black, including tarsi, the posterior tarsi a very little paler, yellowish brown. Wings with a clear yellow tinge; veins and macrotrichia brownish black. Macrotrichia much longer, coarser and more conspicuous than in *niveitarsis*. Venation: *Rs* only a little longer than R_{2+3+4}, the latter not as erect as in either *niveitarsis* or *crystalloptera;* Sc_1 ending nearly opposite the fork of M_{3+4}; R_{1+2} subequal to or only a little shorter than *Rs;* cell M_1 present but small; *m-cu* from one-third to one-half its length beyond the fork of *M;* anterior arculus preserved, though faint.

Abdominal tergites dark brown, the hypopygium and sternites more brownish yellow.

Holotype, ♂, Fusagasuga, altitude 4800 feet, July 30, 1936 (Stone).

Allotype, ♀, with the type.

Paratopotypes, 5 ♂ ♀, July 30–31, 1936.

The nearest ally is the smaller *Polymera* (*Polymera*) *niveitarsis* Alexander, which differs in the details of venation, as the broken arculus, shorter *Sc*, and short, more erect R_{2+3}, and in the snowy-white posterior tarsi. The flagellar segments of the present fly are slightly less cylindrical than in *niveitarsis*, the basal and apical enlargements being feebly indicated.

Polymera (Polymera) ominosa new species.

Mesonotum reddish brown, unmarked; pleura chiefly occupied by a black dorsal stripe; fore coxæ blackened, middle and posterior pair almost white; femora brown, the tips very narrowly whitened; tarsi brown, the posterior pair a little brighter, more yellowish brown; wings with a very strong brown suffusion; *Sc* unusually long, Sc_1 ending some distance beyond origin of vein R_{2+3}; vein *R* unusually short, only a little longer than *Rs*; both R_{1+2} and *Rs* longer than R_{2+3+4}; abdomen black, including the hypovalvæ of the ovipositor.

FEMALE.—Length about 6 mm.; wing 6.8 mm.

Rostrum and palpi dark brown. Antennæ with the scape and pedicel brown; flagellum black. Head dark brownish gray.

Pronotum testaceous yellow. Mesonotum uniformly light reddish brown, unmarked. Entire dorso-pleural region black, only the ventral sternopleurite and meral region light reddish brown. Halteres dark brown, the base of stem restrictedly pale. Legs with the fore coxæ blackened, middle and hind coxæ almost white; trochanters obscure brownish yellow; femora brown, more yellowish basally, deepening to a narrow, still darker, subterminal ring, the extreme tip abruptly whitened; tibiæ brown, the bases not or scarcely brightened; tarsi brown, the posterior tarsi a very little paler, more yellowish brown. Wings with a very strong brown suffusion, cells *C* and *Sc* a little more yellowish; veins and trochanters dark brown. Venation: *Sc* of unusual length, Sc_1 ending some distance beyond the origin of vein R_{2+3} and about opposite the fork of M_{3+4}; vein *R* unusually short, only a little longer than *Rs*; R_{1+2} and *Rs* subequal, longer than R_{2+3+4}; cell M_1 present; *m-cu* more than its length beyond the fork of *M*.

Abdomen black, including the hypovalvae; cerci brown, the tips paling to horn-yellow.

Holotype, ♀, Fusagasuga, altitude 4800 feet, July 31, 1936 (Stone).

In the white femoral tips, the present fly agrees most nearly with the otherwise very distinct *Polymera* (*Polymera*) *albogeniculata* Alexander (Ecuador) and *P.* (*P.*) *geniculata* Alexander (Puerto Rico). The unusually dark-colored but unpatterned wings suggest *P.* (*P.*) *cinereipennis* Alexander (Paraguay) and P. (*P.*) *fuscitarsis* Alexander (southern Brazil) but the fly is entirely distinct. The unusually long vein *Sc* and the short *R* furnish strong venational characters.

Genus *Gonomyia* Meigen

Gonomyia (Lipophleps) cervaria new species.

Belongs to the *manca* group; mesonotal praescutum and scutal lobes brown; scutellum yellow, narrowly darkened medially; pleura with a conspicuous white longitudinal stripe; legs brown; wings with a weak brown tinge, the outer radial portion a little darker; male hypopygium with the outer dististyle a very strongly curved blackened structure, terminating in an acute spine and with a few smaller denticles along outer margin; phallosome consisting of two pairs of blackened hooks, these of unequal size.

Male.—Length about 3 mm.; wing 3.8 mm.

Rostrum brownish black; palpi black. Antennæ black; flagellar segments long, with very elongate verticils. Head yellow, the center of vertex blackened.

Pronotum and anterior lateral pretergites clear light yellow. Mesonotal praescutum and the scutal lobes dark brown; median region of scutum and the scutellum obscure yellow, the latter narrowly darkened medially; postnotum yellow, with a dark brown triangle at cephalic end and with the posterior third darkened, restricting the ground-color to a V-shaped central area. Pleura brown, with a conspicuous white longitudinal stripe extending from the fore coxæ to base of abdomen, passing beneath the root of halteres, the area narrowly bordered both dorsally and ventrally by still darker brown. Halteres pale yellow. Legs with the fore coxæ darkened, remaining coxæ and all trochanters pale yellow; remainder of legs dark brown, the femora slightly paler on basal portions. Wings faintly tinged with brown, somewhat more saturated in the stigmal and outer radial portions but with the actual stigma not or scarcely delimited; costal region narrowly pale; veins pale brown. Venation: Sc_1 ending shortly before origin of *Rs;* m-cu at fork of *M.*

Abdomen brown, the hypopygium more yellowish. Male hypopygium with the outer lobe of basistyle produced into a fleshy lobe. Outer dististyle a powerful blackened structure, curved almost into a circle, gradually narrowed outwardly and terminating in a strong spine; outer margin on basal half with two or three small spines; a conspicuous appressed spine on outer margin at near two-thirds the length. Inner dististyle a small oval pale structure, with numerous setæ, including a terminal fasciculate bristle. Phallosome consisting of two pairs of structures, the longest appearing as black crook-like hooks, the shorter pair terminating in long, gently curved black spines and a shorter, more basal, blackened tooth.

Holotype, ♂, Fusagasuga, altitude 4800 feet, July 31, 1936 (Stone).

The nearest allied species are *Gonomyia* (*Lipophleps*) *basispinosa* Alexander (southern Brazil) and *G.* (*L.*) *bruchi* Alexander (Argentina), which have a somewhat similar phallosome, arranged as two paired and blackened sets of structures, but which differ conspicuously in the conformation of the styli of the hypopygium.

Genus *Molophilus* Curtis

Molophilus luxuriosus new species.

Belongs to the *plagiatus* group; size large (wing, male, 5.5 mm. or more); general coloration dark brownish gray; antennæ relatively short in both sexes; halteres yellow; legs brown to brownish black; wings whitish subhyaline, variegated with darker, including a band at cord; male hypopygium with the basal dististyle a nearly straight blackened rod, the mesal edge with a series of spines and spinous setæ.

MALE.—Length about 4–4.5 mm.; wing 5.5–6 mm.

FEMALE.—Length about 5 mm.; wing 6.8 mm.

Rostrum brown; palpi black. Antennæ brownish black throughout, relatively short in both sexes; flagellar segments oval to subtruncate; longest verticils much exceeding the segments. Head gray.

Mesonotum almost uniformly dark brownish gray, the humeral region of praescutum more brightened; lateral pretergites yellow; praescutum with two intermediate dusky vittæ occupying the position of the interspaces, reaching the anterior border of sclerite, delimited by black setæ; pseudosutural foveæ black. Pleura dark gray. Halteres yellow. Legs with the coxæ dark gray; trochanters brownish yellow; remainder of legs brown to brownish black, the femoral bases a little brightened, the tibial tips narrowly blackened. Wings whitish subhyaline, in the more heavily patterned individuals with two dusky bands, the outer one along the cord, the inner area involving the central portions of the cubital and anal cells; in other specimens, only the dark fascia on the anterior cord is indicated; in the female assigned to this species, the axillary region is weakly darkened; veins yellow to pale brown, darker in the clouded areas; trichia dark. Venation: Petiole of cell M_3 a little longer than *m-cu;* vein *2nd A* relatively long, ending opposite *m-cu.*

Abdomen, including hypopygium, brownish black. Male hypopygium with the apical beak of basistyle relatively deep. Outer dististyle with the inner arm slightly longer and narrower than the outer arm, the latter truncated at apex. Basal dististyle a nearly straight blackened rod that terminates in an acute, slightly bent spine; lower or mesal edge of style almost to base with a series of spines and spinous setæ; the strong outer spines are about 20 to 22 in number, on the basal half of style being replaced by more slender spinous setæ forming a dense linear group of brush, exceeding 25 to 30 in number. In the allied *capricornis,* the slender basal spines are few (5 or 6) in number and do not form a specialized area.

Holotype, ♂, Usme, altitude 10,000 feet, July 8, 1936 (Stone).

Allotopotype, ♀, with type.

Paratopotype, ♂, July 9, 1936.

Molophilus luxuriosus is most nearly allied to *M. capricornis* Alexander (Colombia), differing in the large size and structure of the male hypopygium, especially the basal dististyle. It should

be noted that in both these species, the denticles of this style are along the mesal or inner edge, and not on the outer margin as in species allied to *Molophilus perseus* Alexander, as *M. chiriquiensis* Alexander, *M. pallatangensis* Alexander and *M. sagittarius* Alexander.

Molophilus lictor new species.

Belongs to the *plagiatus* group; mesonotal praescutum and scutum reddish brown, the former more darkened on margin behind the pseudo-sutural foveæ; posterior sclerites of mesonotum, and the pleura, dark brown; antennæ (male) of moderate length; wings dark gray, the prearcular and costal regions clearer yellow; male hypopygium with the apical beak of basistyle very slender; basal dististyle a short powerful blackened club, the apex densely set with strong black spines to produce a mace-like appearance.

MALE.—Length about 3.6–3.8 mm.; wing 4.5–4.7 mm.

Rostrum and palpi black. Antennæ black throughout, moderately long, if bent backward reaching nearly to wing-root; flagellar segments oval to long oval, with a dense erect pubescence and long, unilaterally arranged verticils. Head dark brown.

Pronotum dark brown, the restricted lateral pretergites obscure yellow. Mesonotal praescutum reddish brown, darker laterally behind the pseudosutural foveæ; scutum reddish brown, the scutellum and mediotergite darker. Pleura and pleurotergite almost uniformly dark brown; pleurotergite with a conspicuous group of long yellow setæ. Halteres pale yellow. Legs with the fore coxæ infuscated, the remaining coxæ a little paler; trochanters yellow; remainder of legs passing from yellowish brown to black, the vestiture dark. Wings relatively broad, dark gray, the prearcular and costal areas, together with cell R_1 clearer yellow; stigmal area a little darker; veins pale brown, brighter in the yellow areas; macrotrichia dark. Venation: R_{2+3} and R_{4+5} subequal, R_2 lying opposite or just beyond the fork of the latter vein; petiole of cell M_3 nearly twice *m-cu;* vein *2nd A* long, ending nearly opposite the fork of M_{3+4}.

Abdomen black, the hypopygium a trifle brighter. Male hypopygium with the apical beak of basistyle very slender, spiniform. Outer dististyle with outer arm short and broad, truncated at apex, the mesal edge microscopically roughened; inner arm longer, slender, the narrow apex obtuse. Basal dististyle a short powerful blackened club, slightly expanded outwardly, the apex densely set with strong black spines to produce a mace-like appearance; outer margin of style before apex with a small isolated group of spines and with small scattered denticles on distal half of outer margin. Phallosome glabrous, the apex obtusely truncated.

Holotype, ♂, Fusagasuga, altitude 4800 feet, July 31, 1936 (Stone).

Paratopotype, ♂.

There is no close ally of the present fly in the Neotropical fauna.

The species with the hypopygium most generally similar is *Molophilus catamarcensis* Alexander (Argentina), but the resemblance is not particularly close.

Molophilus conscriptus new species.

Belongs to the *plagiatus* group; mesonotum rather dark brown, the scutellum blackened; antennæ (male) elongate, approximately two-thirds the length of the body, the segments fusiform; thoracic pleura obscure yellow, with two narrow blackish longitudinal stripes; legs brown; wings relatively narrow, with a strong dusky tinge; male hypopygium with the basal dististyle unusually long and slender, a little expanded and twisted at apex, the tip produced into a powerful spine.

MALE.—Length about 3 mm.; wing 3.7 mm.; antenna about 2 mm.

Rostrum and palpi brownish black. Antennæ (male) elongate, as shown by the measurements; scape and pedicel obscure yellow, flagellum dark brown; flagellar segments fusiform, the outer end more strongly narrowed than the base, the central portion of the segment with whorls of long erect verticils and pubescence. Head dark gray.

Cervical region blackened. Anterior lateral pretergites and pronotum pale yellow. Mesonotal praescutum rather dark brown, the humeral region more brightened; scutum with lobes dark brown, the median area obscure yellow; scutellum blackened; postnotum dark. Pleura obscure yellow, with two narrow blackish longitudinal stripes, the more dorsal one extending from the cervical region across the dorsal pleurites and dorsopleural membrane to the pleurotergite, passing above the root of the halteres; ventral stripe less distinct, beginning behind the fore coxæ. Halteres yellow. Legs with the coxæ and trochanters obscure yellow; remainder of legs brown, the outer segments more blackened. Wings relatively narrow, with a strong dusky tinge, the veins vaguely seamed with still darker; veins and macrotrichia dark. Venation: R_2 lying distad of level of *r-m;* petiole of cell M_3 unusually long, nearly three times *m-cu;* vein *2nd A* short, ending just before a level of *m-cu,* the cell narrow, especially at outer end.

Abdomen, including hypopygium, brownish black. Male hypopygium with the apical beak of basistyle relatively slender, the outer end a little expanded and twisted, at apex produced into a powerful spine that is surrounded at base by several small setæ.

Holotype, ♂, Fusagasuga, altitude 4800 feet, July 31, 1936 (Stone).

The species in the Neotropical fauna having the male hypopygium most similar to that of the present fly are *Molophilus flexilistylus* Alexander (Colombia) and *M. remiger* Alexander (southern Brazil), both of which have the antennæ short in both sexes, the wings broad, and with the structure of the basal dististyle of the male hypopygium entirely different.

ACENTROPUS IN AMERICA (LEPIDOPTERA, PYRALIDIDÆ)

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I took a fresh male of *Acentropus niveus* Olivier at light, at the Alfalfa Snout-Beetle Experiment Station, Minetto, N. Y., June 22, 1938. So far as I can find out this is the first record for North America.

The moth is easily distinguished from any other local Pyralid by the translucent white wings and contrasting drooping blackish palpi. Structurally it belongs to the Schoenobiinæ, with tongue obsolete, 1st A preserved toward margin in forewing, and no fringe on base of Cu of hind wing. In this subfamily it is unique in having the spurs of middle and hind tibiæ rudimentary, and M_1 of hind wing widely separated from the upper angle of the cell.

The life history is well known in Europe, and is absolutely unique; the larva forms a case—much like the Nymphulinæ, but cylindrical—and feeds on submerged plants; most female moths are wingless, and live wholly under water, only coming to the surface to mate, but an occasional female is winged, much like the male, and doubtless serves to distribute the species to new stations. Accounts may be found in Die Süsswasserfauna Deutschlands viii, p. 149, by Grünberg, and in most other European works on aquatic life.

The wing form is obviously variable. The present specimen has pointed wings, as figured by Hampson (Proc. Zool. Soc., 1895, 919) but the winged pair in our collection has them much more rounded, as figured by Grünberg.

WESTERN ORTHOPTERA ATTRACTED TO LIGHTS

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The number of species of Orthoptera recorded as coming to light is extremely small in number. Rockwood (1924), who has published the only list of Orthoptera (Acrididæ) taken at light, reports only fourteen species recorded in the literature for North America. Nine of these were taken from the writings of Rehn and Hebard.

The paucity of reports appears to be due to several factors, namely: the scarcity of observers throughout the country, and in the unusualness of the event in the more northern latitudes of our country where the desultory appearance of Orthoptera at light usually escapes the attention of most workers.

Geographical location seems to play an important role in determining the abundance of species coming to light, and this appears to be directly influenced by the weather conditions prevailing in that particular region.

Positive phototaxis appears to be related to temperature; a temperature above 80 degrees Fah. apparently is a prerequisite of night flying activity with the maximum activity above 90 degrees. This is a contradiction to the results obtained by Parker (1924) and Sviridenko (1924) in their respective studies on *Camnula pellucida* Sc. and *Docioataurus maroccanus* Thunbg. Although they found that temperatures in the neighborhood of 90 degrees Fah. tend to inhibit the movements of these two species, it does not necessarily follow that other species of Orthoptera behave in a similar manner. Quite the reverse seems to be true. The great majority of species recorded and reported in this paper, based on the author's observations, come from the desert regions of southwestern United States. In such regions it is only natural to suspect that life activity optimums for the species inhabiting the desert are much higher than for northern species such as *Camnula pellucida*.

In the northern tier of states very few Orthopterans are attracted to light and those that come are mainly Tettigoniids and Gryllids. It is interesting to note here that during the summer of 1932 the writer took three species of Orthoptera, namely: *Dissosteira carolina* L., *Spharagemon collare* (Sc.) and *Scudderia furcata furcata* Br., at North Branch, Minnesota, the night of July 14, 1932, 9–11 p.m. when the thermometer registered over 95 degrees. The day had been one of the hottest in many years in Minnesota, the shade temperature reaching a maximum of 104 degrees in the late afternoon. While at El Centro in the Imperial Valley of southern California on the night of August 25, 1931, at 7:30 p.m. with a temperature of at least 105 degrees (the late afternoon temperature had been 122 degrees) the writer observed large numbers of *Gryllus assimilis* flying with unusual activity around the street and store lights and running around on the ground below and flying and jumping up into the air towards the object of attraction.

The above remarks are further substantiated by the following observations. For two years, from 1928 to 1930, the author was stationed at the Pink Bollworm Laboratory at Presidio, in the Rio Grande valley of southwestern Texas. There he had an excellent opportunity to observe and collect specimens of the large number of Orthopteran species attracted to the street lights.

Several factors appear to directly influence the nocturnal activity of the Orthoptera in the regions of the Southwest.

Of these temperature is undoubtedly the most important single factor. Early night temperatures during the hottest part of the year when the Orthoptera exhibit their greatest phototaxis seldom ranges below 88 degrees. Hence it appears that high temperatures are conducive to greater activity and light attractivity in the Orthoptera. The following temperature readings from the Hygrothermograph at Presidio, are for the period when the largest number of Orthoptera were coming to light during the 1929 season.

The paucity of the vegetation and its low growth lends favorably to the penetration of light to much greater distance than could be expected in wooded regions such as Minnesota where the density of vegetation and its greenness prevent and absorb much of the light.

Furthermore the desert floor is usually bare, and is in south-

August	8 p.m. temp.	9 p.m. temp.	August	8 p.m. temp.	9 p.m. temp.
23*	89	87	30	91	88
24*	84	82	31	90	88
25*	92	90	Sept. 1	......	......
26	79	78	2	84	83
27	90	88	3	89	88
28	88	86	4	81	80
29	82	80	5	90	88

* Indicates bright moonlight in the early part of the evening which greatly reduced the numbers attracted to the lights.

western Texas surfaced with whitish clay and often covered to a greater or lesser degree by a layer of whitish gray cobblestones, and forming what is called the "desert pavement." The desert pavement reflects the light resulting in the greater attractivity of that light. We find therefore that moonlight seems to have a profound effect on the abundance of Orthoptera and other insects attracted to light in the desert regions. The nature of the desert pavement, the sparse low vegetation and the clear dry atmosphere gives the moonlight an intensity that is seldom observed outside of desert regions, and this brilliancy mitigates the effect of artificial light.

Orthoptera come to light in maximum abundance about the end of August and in early September, when shortly after the late summer rains, insect life is at a maximum and the greatest number of Orthopteran species are mature. The night temperatures are high, the humidity usually higher than at other times of the year but at that it is very low, with the result that a great variety of insects come to light which seldom appear at lights elsewhere other than in desert regions. Cicindelidæ, Meloidæ, Cerambycidæ and Scarabæidæ come in variety and in large numbers. Occasionally Hemiptera and Homoptera (especially Cicadellidæ), and rarely Cicadidæ, Mecoptera and Rhopalocera and many other interesting visitors are taken, besides the wealth of moths that ordinarily flock to the lights.

Another point of interest upon which the writer has no datum but which will be briefly indicated here is the question: from what distances are Orthoptera attracted to lights and what is the nature of their night flying activity? Are they attracted directly to the light source from the spot upon which they are resting whether soil

or bush or do they fly around at night and are only accidentally brought to the light whenever they come within the sphere of the light's influence? Concerning this problem it may be said that several species such as *Xanthippus corallipes pantherinus* (Sc.), *Rehnita capito* (Stål) and *Mestobregma plattei corrugatum* (Sc.) taken at light at Presidio, Texas, have not been collected closer to Presidio than the Chinati Mountains which are twenty-two miles north of that place. This does not prove that they do not occur in the immediate vicinity but the writer believes he can truthfully say that so far as the Orthopteran fauna is concerned no effort was spared in collecting them during the two-year period September, 1928, to July, 1930; a total of one hundred and twenty-five species of Orthoptera from Presidio County alone might testify to this statement. There is also the astonishing case of *Dissosteira carolina* L. male taken in Presidio on July 16, 1929, by Scout Paul Lujan. It was immediately brought to the writer on account of its strange appearance. This male was taken alive in Childer's Drugstore window (which was one of the more illuminated spots at night) where nightly many insects were attracted into the store by the luring lights. Many insects became trapped by the windows when they tried to escape on the following day. This undoubtedly happened to this male. *Dissosteira carolina* belongs to the Transitional Faunal Zone, the writer having taken the species commonly in southern Alberta, in the north woods along the Ontario-Minnesota Boundary, and at elevations from 5000 to 8000 feet in the Magdalena Mountains, 25 miles west of Socorro, New Mexico; distinctly a northern species. The extreme southern distributional record for Texas was Lubbock, in the Panhandle region, some 800 miles northeast of Presidio and the record for the Magdalena Mountains is still some 600 miles northwest. How then must we account for this strange record? Was it accidentally introduced; was it breeding in the Rio Grande Valley or was it attracted to the lights while migrating from distant regions? *D. carolina* is one of the few acridids previously recorded as attracted to lights, and this species as well as the other members of the genus *Dissosteira* seem to possess strong positive phototaxis. The writer does not doubt that it was attracted to the lights, but to say whence, from the immediate neighborhood or while travel-

ling from more remote regions is a question that may never be answered. Little is known about insect migrations. We are only beginning to understand some of our common migrants such as *Danais plexippus* (L.). But it is not beyond the realm of possibility to imagine that some of our Orthopteran species, especially acridids, have considerable night flying activity, when the climatic conditions are propitious.

Rockwood's paper summarizes the fragmentary literature on the subject up to 1924 and lists the acridids taken at light, principally those reported in the writings of the two eminent Orthopterists, Rehn and Hebard.

Acknowledgment with many thanks is due Morgan Hebard of the Academy of Natural Sciences of Philadelphia, who has from time to time, most kindly identified the writer's collection of West Texas Orthoptera, and who sent the writer during the summers of 1930 and 1931, into the Southwest on collecting expeditions, from whence many notes were made.

The writer has also carefully examined all the Orthoptera in the University of Minnesota Collection (recently determined by Morgan Hebard) and recorded all specimens labelled as coming to light.

The number of specimens recorded as attracted to light, especially from Presidio, Texas, is not indicative of the numbers at light, for in most cases only a portion of those at light were taken for identification purposes.

Below is a list of Western Orthoptera taken at light, by the author, unless otherwise stated. Those previously listed in Rockwood's paper have been designated by an asterisk.

LIST OF WESTERN ORTHOPTERA TAKEN AT LIGHT

Blattidæ

Periplaneta americana (Linn.). Tucson, Arizona, 1 ♀, July 23, 1907, (Hebard). Yuma, Arizona, 1 ♂, July 27, 1907, (Hebard).

Panchlora cubensis Saussure. Montemorelos, Tamaulipas, Mexico, 1 ♂, VI, 3, 31, (A. Dampf; at light), (Mex. Govt.). Hebard, 1932.

Arenivaga apacha (Saussure). El Ysidro, San Diego Co., Calif., 1 ♂, VIII, 22, 31, (probably this species).

Arenivaga erratica Rehn. Yuma, Arizona, 1 ♂, July 27, 1907, (M. Hebard), (recorded as *Homœogamia erratica;* Rehn and Hebard 1908). Presidio, Texas, 8 ♂, IX, 16, 29.

Arenivaga tonkawa Hebard. Nuevo Laredo, Tamaulipas, Mexico, 1 ♂, VI, 8, 31, (A. Dampf; at light), (Hebard Cln.). Hebard, 1932.

Eremoblatta subdiaphana Scudder. Presidio, Texas, 1 ♂, IX, 9, 28; 2 ♂, V, 15, 30; 1 ♂, V, 16, 30. Common at light at Presidio, Texas.

Mantidæ

Stagmomantis californicus Rehn and Hebard. The males of this species come abundantly to light along the southern border of the United States; especially in southwestern Arizona and southwestern New Mexico the males swarmed to the car lights in mid September of 1931.

Stagmomantis limbata Hahn. This species comes to light occasionally at Presidio, Texas.

Litaneutria minor (Scudder). Presidio, Texas, 1 ♂, X, 20, 28. This species comes commonly to light at Presidio. Rodriguez, Nuevo Leon, Mexico, 4 ♂, VI, 7, 1931, (A. Dampf; at light), (Mex. Govt. and Hebard Cln.). Hebard, 1932.

Acrididæ

Acrydiinæ

Tettigidea lateralis (Say). St. Paul, Minn., 1 ♀, VI, 28, 32, (U. Farm Light Trap for 2–3 a.m.). An occasional one in July and August came to the trap.

Acridinæ

Bootettix punctatus (Sc.). This species which lives only in the bushes of the Creosote Bush (*Covillea tridentata*) came to auto lights in the Sauceda Mountains, 22 miles south of Gila Bend, Arizona, on August 30, 1931.

Syrbula fuscovittata Thos. Presidio, Texas, 3 ♀, VIII, 24, 29; females come occasionally, the males rarely to light at Presidio.

Orphulella pelidna (Burm.). Presidio, Texas, 2 ♂, VIII, 24, 29; 2 ♂, VIII, 26, 29; males come occasionally to light.

Orphulella compta Sc. Las Vegas, Nevada, 5 ♀, VII, 31, 30, (E.

R. Tinkham), fairly common at light. Wellton, Arizona, 2 ♂, 4 ♀, VII, 8, 32, (M. J. Oosthuizen).

Scyllium viatoria viatoria (Saussure). Sycamore Canyon, Baboquivari Mts., Pima Co., Arizona, X, 6–9, 1910, 16 ♂, 16 ♀, (Rehn and Hebard; elevation about 3700 feet), (common in short yellow grass, two attracted to light at night). Hebard, 1924.

Ligurotettix coquilletti kunzei Caudell. Sauceda Mts., 22 miles south of Gila Bend, Arizona, 30, VIII, 31; Gila Mts., 11 miles east of Yuma, Arizona, VIII, 26, 31, comes commonly to car lights.

Liguortettix c. kunzei and *Ligurotettix c. cantator* R. and H. intermediate form. Jean, on the California-Nevada Line, southwest of Las Vegas, VI, 27, 32, 22 ♂, 7 ♀, (M. J. Oosthuizen).

Oedipodinæ

Encoptolophus subgracilis Texensis Bruner. Males and females come commonly to light at Presidio, Texas. Reported by Rockwood 1924 as *E. texensis* Br. Rodriguez, Nuevo Leon, Mexico, VI, 5 to 7, 1931, (A. Dampf; at light) 23 ♂, 35 ♀, (Mex. Govt. and Hebard Cln.). Monterrey, Nuevo Leon, VII, 4 and 5, 1908, (at light), 5 ♂, 2 ♀, (Illinois State). Hebard 1932.

Encoptolophus pallidus Bruner. Wellton, Arizona, 2 ♀, VII, 8, 32, (M. J. Oosthuizen).

Xanthippus corallipes pantherinus (Scudder). Marfa, Texas, 1 ♂, 5 ♀, VI, 4, 30. Presidio, Texas, 1 ♂, 1 ♀, VI, 15, 30; 2 ♀, IV, 25, 30. Comes well to light.

Leprus wheeleri (Thomas). Presidio, Texas, 4 ♂, 1 ♀, VIII, 24, 29; 2 ♀, VIII, 29, 29; 1 ♀, IX, 1, 29; 1 ♂, 1 ♀, IX, 4, 29. Males come abundantly to light at Presidio but only a few females.

**Dissosteira carolina* (Linn.) Presidio, Texas, 1 ♂, VII, 16, 29, (Scout Paul Lujan). North Branch, Minn., 1 ♂, VII, 14, 32, (E. R. Tinkham). Minneapolis, Minn., 1 ♂, VIII, 6, 32, (D. G. Denning).

**Dissosteira longipennis* (Thomas). Various records in the literature according to Rockwood, 1924.

**Dissosteira spurcata* Saussure. Salt Lake City, Utah, 2 ♀, VII, 25, 31.

Spharagemon collare collare (Scudder). North Branch, Minnesota, 1 ♀, VII, 14, 32, street lights.

Spharagemon collare cristatum Scudder. This species comes occasionally to light at Presidio, Texas.

**Spharagemon equale* (Say). Salt Lake City, Utah, 1 ♀, VII, 25, 31, city lights.

Derotmema delicatulum Scudder. Las Vegas, Nevada, 4 ♂, VII, 31, 30 (E. R. Tinkham) (Hebard Cln.). Wellton, Arizona, 1 ♂, VII, 8, 32 (M. J. Oosthuizen). This species comes readily to light.

Trachyrhachis kiowa fuscifrons (Stål). A few taken at light at Presidio.

Rehnacris capito (Stål). Presidio, Texas, 1 ♂, 4 ♀, VIII, 24, 29. It is interesting to note that this species during two years of intensive collecting has never been taken closer than the Chinati Mountains, 22 miles north of Presidio.

Mestobregma plattei corrugatum (Scudder). At Presidio a few females were taken at light but no males.

Mestobregma impexum Rehn. Salt Lake City, Utah, 1 ♀, VII, 25, 31, city lights.

**Conozoa sulcifrons wallula* Scudder. Reported by Rockwood, 1924, 3 ♀ from Boise, Idaho, July 22, 1923.

Conozoa sulcifrons Scudder. Las Vegas, Nevada, 1 ♀, VII, 31, 30 (E. R. Tinkham). Wellton, Arizona, 1 ♂, VII, 8, 32 (M. J. Oosthuizen).

**Trimerotropis texana* Bruner. Presidio, Texas, 1 ♀, VIII, 31, 29; 1 ♂, IX, 3, 29. This species comes only rarely at light at Presidio as it is one of the uncommon species of the region.

**Trimerotropis strenua* McNeill. Tucson, Arizona, 2 specimens, VII, 26, 07 (Rehn and Hebard). Rehn and Hebard, 1908.

Trimerotropis cæruleipennis Bruner. Nevada desert, 15 miles north of Coleville, Calif., several specimens, VIII, 8, 30, attracted to light of Coleman lantern.

**Trimerotropis pallidipennis pallidipennis* (Burm.). Both sexes attracted abundantly to lights throughout the entire desert region. West of Jean on the California-Nevada Line, 2 ♂, 8 ♀, VI, 27, 32 (M. J. Oosthuizen). Recorded by Rockwood, 1924, from Rehn and Hebard, 1908 and 1909, as the synonymous *Trimerotropis vinculata* Scudder, from Alamogordo, New Mexico, 1 sp., July 12, 1907, and Nogales, Ariz., 1 ♂, VIII, 13, 1907.

**Trimerotropis citrina* Scudder. Presidio, Texas, 2 ♀, IX, 4, 29, Raleigh, N. Carolina, 1 ♂, VIII, 19, 04, electric light, (Univ. of Minn. Cln.). Recorded by Rockwood through Rehn and Hebard, 1909, as the synonymous *T. rubripes* Rehn from Alamogordo, New Mexico, 1 ♀, July 12, 1907. Males and females of this species come frequently to light at Presidio.

Trimerotropis laticincta Saussure. Rodriguez, Nuevo Leon, Mexico, VI, 6 and 7, 1931, (A. Dampf; at light) 1 ♂, 2 ♀, (Mex. Govt. and Hebard Cln.). Hebard, 1932. Presidio, Texas, VIII, 24, 29, rare in this region.

Trimerotropis tolteca modesta Bruner. Nogales, Arizona, 1 ♀, VIII, 13, 06, (Dr. Calvert). Rehn and Hebard, 1908 (as *fascicula*).

Anconia integra Scudder. Las Vegas, Nevada, 4 ♂, 3 ♀, VII, 31, 30, (E. R. Tinkham). West of Jean on the California-Nevada Line, 3 ♂, 4 ♀, VI, 27, 32, (M. J. Oosthuizen). This species comes readily to light.

Cyrtacanthracrinæ

Eremiacris pallida Bruner. Las Vegas, Nevada, 1 ♂, 1 ♀, VII, 31, 30. Yermo, Calif., 2 ♀, VIII, 15, 31. Eleven miles east of Yuma, Arizona, a few specimens coming to car light, VIII, 26, 31. This species comes well to light.

Hesperotettix viridis viridis (Thomas). Wellton, Arizona, 1 ♂, VII, 8, 32, (M. J. Oosthuizen).

Æolopus tenuipennis tenuipennis Scudder. Yuma, Arizona, 7 specs., July 27 and 28, 1907, (Rehn and Hebard) (as *arizonensis*). West of Jean on the Californian-Nevada Line, 9 ♂, 9 ♀, VI, 27, 32, (M. J. Oosthuizen). This species appears to be attracted to light abundantly.

Melanoplus mexicanus mexicanus (Saussure). Wellton, Arizona, 1 ♂, VII, 8, 32, (M. J. Oosthuizen).

**Melanoplus herbaceus* Bruner. Alamogordo, New Mexico, 1 ♀, July 12, 1907, (Rehn and Hebard). Rehn and Hebard, 1909.

Tettigoniidæ

Phanerotropinæ

Arethæa gracilipes papago Hebard. Oracle, Arizona, 4 ♂, 2 ♀, IX, 8, 31, (filling station lights).

Insara elegans elegans (Scudder). Presidio, Texas, 1 ♀, VIII, 28, 29; 1 ♀, V, 18, 30. Deming, New Mexico, 2 ♀, July 20, 1907, at lights, (Rehn and Hebard). Rehn and Hebard, 1909.

Insara elegans conseutipes (Scudder). Oracle, Arizona, 1 ♂, IX, 8, 31, (filling station lights).

Insara covillea Rehn and Hebard. Sauceda Mts., 22 miles south of Gila Bend, Arizona, 5 ♂, 2 ♀, VIII, 30, 31. Ajo, Arizona, 2 ♀, VIII, 31, 31. This species came in fair numbers to car lights.

Scudderia pistillata Bruner. St. Paul, Minn., 1 ♂, VII, 6, 21, (Wm. E. Hoffmann; Como Park lights). St. Paul, Minn., 1 ♀, VI, 29, 21, (Wm. E. Hoffmann), (Univ. of Minn. Cln.).

Scudderia furcata furcata Bruner. North Branch, Minn., 1 ♂, VII, 14, 32. Rodriguez, Nuevo Leon, Mexico, VI, 5 and 6, 1931, (A. Dampf; at light), 5 ♂, (Mex. Govt. and Hebard Cln.). Hebard, 1932.

Scudderia furcata furcifera Scudder. Oracle, Arizona, 2 ♀, IX, 8, 29, (filling station lights).

Microcentrum rhombifolium (Saussure). El Paso, Texas, 1 ♂, IX, 18, 31; Oracle, Arizona, 4 ♂, 1 ♀, (collected at filling station lights in late September for E. R. Tinkham by station man). Nogales, Arizona, 1 ♀, VIII, 13, 06, (Dr. Calvert). Rehn and Hebard, 1908.

Microcentrum californicum Hebard. Campo, San Diego Co., Calif., 2400 feet elev., (M. Hebard) 2 ♂, Type and Paratype, (Hebard Cln.). This new species was described by Hebard in 1932. Oracle, Arizona, 12 ♂, (collected at filling station lights in late September for E. R. Tinkham). This species, an oak inhabitant, came in fair numbers to light while *Microcentrum rhombifolium* living in the cottonwood trees did not seem to be attracted as readily.

Microcentrum stylatum Hebard. Eden, Pis Pis District, Nicaragua, IV, 23 to V, 21, 1922, (W. Huber; at light), 5 ♂ (Acad. Nat. Sci. Phila. and Hebard Cln.). This species was described as new by Hebard, 1932.

Microcentrum myrtifolium Saussure and Pictet. Cuernavaca, Morelos, Mexico, 1 ♂, VII, 1 to 5, 1905, (W. L. Tower; at light), (Amer. Mus. Nat. Hist.). Hebard, 1932.

Anaulacomera laticauda Bruner. Santa Isabel, Sierra Madre,

Chiapas, Mexico, XI, 17, 1930, (at light), 1 ♀, (Hebard Cln.). Hebard, 1932.

Phylloptera festæ Griffini. Near Santa Lurecia, Vera Cruz, Mexico, XI, 9, 30, (on light in train), 1 ♂, (Hebard Cln.). Hebard, 1932.

Copiphorinæ

Neoconocephalus ensiger (Harris). Minneapolis, Minn., 1 ♂, VII, 24, 32, (D. G. Denning; city lights).

Neoconocephalus robustus crepitans (Sc.). Lincoln, Nebraska, 1 ♂, Sept.; 1 ♀, Aug., (taken at light), (Univ. of Minn. Cln.).

Conocephalinæ

Conocephalus fasciatus fasciatus (DeGeer). Minneapolis, Minn., 1 ♂, VII, 24, 32, (D. G. Denning; at street lights).

Decticinæ

Anoplodusa arizonensis (Rehn). Barstow, California, 1 ♂, April, 1931, (Guy Beevor), (Hebard Cln.). Yermo, Calif., 1 ♂, VI, 26, 32, (M. J. Oosthuizen). This is one of the rarest decticids in North America.

Capnobates fuliginosus Thomas. This species is stated as being attracted to lights at Yermo, California, by Mr. Guy Beevor. It appeared to show a positive phototaxis to the light from a Coleman lantern while collecting in the Quinlan Mountains about 80 miles west of Tucson, Arizona, the night of September 3, 1931. These two genera are the only fully winged ones of this subfamily found in North America.

Rhaphidophorinæ

Ceuthophilus variegatus Scudder. A large specimen was taken at Presidio, Texas, in late August, 1929, under a street light to which it had been attracted.

Gryllidæ

Gryllinæ

Gryllus assimilis Fab. Faribault, Minn., 1 sp., VI, 19, 22, (Wm. E. Hoffmann).

Gryllus assimilis phase *personatus*. Presidio, Texas, 1 ♂, VIII, 24, 29; 1 ♂, IX, 1, 29. Springerville, Ariz., 2 ♀, VII, 23, 30.

Wellton, Ariz., 3 ♂, 8 ♀, VII, 8, 32, (M. J. Oosthuizen). Tucson, Ariz., 20 ♂, 18 ♀, Jul. 23–26, 1907, (Rehn and Hebard). Rehn and Hebard, 1908.

Miogryllus lineatus Scudder. Wellton, Arizona, 1 ♂, 5 ♀, VII, 8, 32, (M. J. Oosthuizen).

Nemobiinæ

Nemobius fasciatus fasciatus (DeGeer). A number of this species was taken during July and August, 1932, in the Light Trap on the University Farm at St. Paul, Minnesota. Abundant around street lights in Minneapolis on August 14, 1932, (D. G. Denning).

Nemobius fasciatus socius Scudder. This species was very common around street light during July and August, 1928, at Tallulah, Louisiana.

Nemobius carolinus carolinus Scudder. University Farm, St. Paul, Minn., 1 ♂, 1 ♀, VII, 25, 21, (Wm. E. Hoffmann; at lights).

Nemobius carolinus neomexicanus Scudder. Tucson, Ariz., 1 ♀, VII, 23, 08, (Rehn and Hebard), Rehn and Hebard, 1908. Yuma, Ariz., 3 ♀, VII, 27–28, 08, (Rehn and Hebard). Eastland Co., Texas, 1 ♂, XI, 8, 21, Grace O. Wiley.

Œcanthinæ

Œcanthus nigricornis argentinus Saussure. Tucson, Arizona, 1 ♂, 1 ♀, Vll, 23–26, 1908, (Rehn and Hebard). Rehn and Hebard, 1908 (as *quadripunctatus*).

Œcanthus niveus (DeGeer). St. Peter, Minn, 1 ♂, VIII, 10, 22, (Sam Kepperly; fish hatchery lights).

Œcanthus californicus Saussure. This species comes occasionally to light at Presidio, Texas.

Mogoplistinæ

Cycloptilum trigonipalpum (Rehn and Hebard). Gainesville, Fla., VII to X, 17, 1923 to 1925, (Hubbell, Walker, Alexander; in room attracted to light during night, under street light) part of 4 ♂, 8 ♀, (Univ. of Michigan Cln.). Hebard, 1931.

Cycloptilum comprehendens fortior Hebard. Kvitak, east of Quijotoa Mountains, 1530 feet, 1 ♂, 1 ♀, IX, 15, 24, (Rehn and Hebard; taken at light). Batamote Well, Valley of the Ajo, 1500

feet, 1 ♂, 1 ♀, IX, 16, 24, (Rehn and Hebard; attracted to camp light at night). Hebard, 1931.

Hoplosphyrum boreale (Scudder). South base of Atascosa Mountain, Santa Cruz Co., 5100 feet, 1 ♀, IX, 22, 24, (Rehn; attracted to light in camp). Hebard, 1931.

SUMMARY

From a perusal of the Orthoptera listed as attracted to light certain general observations can be made.

It is apparent that certain subfamilies are attracted to light better than others. The subfamily Polyphaginæ, comprised mainly of desert blattids, come well to light but only in the males as many of these species have apterous females. The mantids, especially the males, possess a strong attraction for light. The females rarely appear, principally due to the great difficulty they find in moving their fat and heavy bodies by wing power. In the Acrididæ, the grouse or pygmy grasshoppers of the family Acrydiinæ, appear to show a poor response, but this is probably due to the paucity of this subfamily in desert regions. The writer believes that many eastern species will be taken at light. Certain genera of the Acridinæ especially those centering around *Syrbula, Orphulella* and *Scyllina,* which are strong flyers, show a strong positive phototaxis. Some genera of the Acridinæ are brachypterous and cannot be expected to appear at light and other genera will eventually be found appearing at light. The banded winged grasshoppers of the subfamily Œdipodinæ are all fully winged and strong flying species and exhibit the strongest phototaxis of any of the subfamilies of the Acrididæ. The genera *Leprus, Dissosteira, Spharagemon, Mestobregma* and *Trimerotropis* show the greatest attraction, but strange enough *Arphia,* the first of the Œdipodine genera, does not appear ot be attracted at all. The Cyrtacanthacrinæ possess at most only a feeble interest in light, and aside from the genus *Eremiacris,* I have never taken a specimen at light. The genus *Melanoplus,* the largest in North America and comprising many fully winged species, would appear from the few records, to show only a weak positive phototropic response.

All the Tettigoniidæ in the winged species appear to come

abundantly to light, especially, the members of the subfamily Phaneropterinæ. All the genera of the Decticinæ except *Anoplodusa* and *Capnobotes* are brachypterous, and the Rhaphidophorinæ without exception are apterous and hence if positively phototropic could only appear at light by hopping to it.

The Gryllidæ possess the strongest light attraction of all the families of the Orthoptera and the Gryllinæ and the Nemobiinæ are seen commonly at light when no other Orthopterans are present. It is interesting to note that the Tettigoniidæ and the Gryllidæ behave like the Heterocera showing a strong phototaxis to light of weak intensity and a strongly negative reaction to intense light, such as daylight or sunlight.

The writer realizes the list is incomplete with practically no mention of eastern and southeastern species, but by its very incompleteness it is hoped this paper may stimulate interest in this line.

COMMENTS BY MORGAN HEBARD

Since the preparation of this paper by E. R. Tinkham a number of additional records of Orthoptera attracted to light in the southwestern United States have been published. Although it is true that many Cyrtacanthacrinæ do not seem to be attracted to light, we found that, considering its scarcity, individuals of *Melanoplus splendidus* came to light surprisingly often near Santa Fé, New Mexico, while *Capnobotes bruneri*, a carnivorous decticid, which in the early summer was there abundant, did so in far lower ratio.

Our observations at Santa Fé further showed very definitely that Orthoptera came to light for two very different reasons. Thus *Arenivaga* and a number of other little if at all predatory species were confused and dazzled; on the other hand such fierce carnivores as *Stagmomantis limbata*, *Stenopelmatus fuscus* and several species of *Ceuthophilus* were often at the lights, not at all confused and evidently engaged in hunting. A specimen of *Stagmomantis limbata*, hiding on the back of the light reflector and poised to grasp the first moth which might come in reach, illustrated this particularly well. We must confess, on the other hand, that we were and are decidedly puzzled by the fact that, though not at all common in the vicinity, individuals of *Pseudosermyle straminea* came to light a number of times. Both males

and females of that walking-stick, at such a time, were invariably very alert and not at all confused, but the species is certainly not predatory. Warm evenings were, as is well known, the best for such collecting, but a number of single captures of particular interest were made on chilly evenings late in the season. Though showers seemed to have little effect, this was probably due to the almost invariable and immediate sharp drop in temperature at 7000 feet, though the region is decidedly arid and was particularly so in 1934. In the arid lowlands of the southwestern United States we have found collecting of Orthoptera at light usually productive of small results, but on some nights Orthoptera appears there about lights in enormous numbers. This we believe is due to heat and showers (which so rarely occur there), but it seems quite probable that other unknown factors are of as great if not even greater importance.

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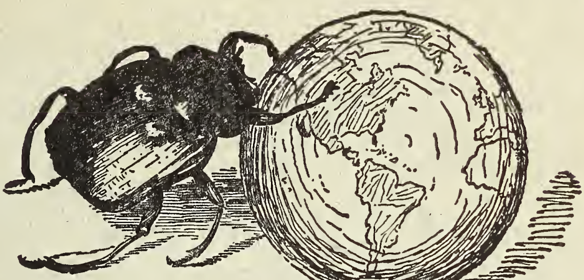

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PHYLOGENY OF SOME CALLIMOMID GENERA (PARASITIC HYMENOPTERA)[1]

By Osmond P. Breland[2]

INTRODUCTION

This is a study of the phylogenetic positions of several genera and subfamilies of the Callimomidae. I have not had access to the tropical members of the family, and thus this study will not be complete, but it may give a better understanding of the evolution of the genera and subfamilies which have been considered.

In considering the phylogeny of any of the families of the Chalcidoidea, one is handicapped, because no one has carefully worked out the evolution of the families which constitute that

[1] Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy from the Graduate School of Indiana University.

Contribution from the Zoological Laboratory of Indiana University No. 260 (Entomological Series No. 16).

[2] I wish to express my appreciation to the members of the Zoology Department at Indiana University, Dr. Fernandas Payne, Dr. Will Scott, Dr. Alfred C. Kinsey, Dr. T. W. Torrey, and Dr. Robert L. Kroc, for helpful advice and criticism in the preparation of this paper. I am especially indebted to Dr. Kinsey, who has supervised my work and who, with the aid of the Department of Zoology, has made possible three extensive field trips, and who also has supplied me with many of the insects in my collection. Thanks are also due to the following:

To Mr. A. F. Satterthwaite, Bureau of Entomology, Webster Grove, Missouri, who has supplied me with a quantity of Callimomidae bred from sunflower and artichoke insects:

To Mr. J. H. Bigger, field entomologist of the Natural History Survey of Illinois, Jacksonville, Illinois, from whom I obtained many insects bred from wheat.

group. As is well known, the chalcidoids are probably as specialized or more specialized than any of the other large groups of the Hymenoptera, but one cannot always be sure whether obvious simplicity denotes primitiveness or specialization.

However, one also finds this an interesting group with which to work, because of the variety of habits exhibited. Parasitism is the outstanding phenomenon common to the family as a whole. The wasps are parasitic upon several orders of insects in the egg, larval, pupal, and even newly emerged adult stages. Some genera or subfamilies seem to be highly specialized in their choice, while others attack widely different hosts. Phytophagy is known to occur in at least two subfamilies with possibilities that the phenomenon occurs in others. There are also indications of parthenogenesis and polyembryony in the family.

The group with which we are dealing is one of the families of the Chalcidoidea (or a subfamily of the Chalcididæ as older workers and even many present day workers call it). The name Callimomidæ, based on the oldest generic name in the family, seems preferable to the name Torymidae which is also applied to the group. I have used the currently accepted generic names practically without critical revision.

As for the affinites of the Callimomidæ, Ashmead (1896) and others, have suggested that this group was derived from the cynipoids, and there certainly are obvious affinities between the two groups. It has likewise been suggested that the Callimomidæ are most closely related to the Eurytomidæ, Chalcididæ, and Agionidæ among the chalcidoids. Before one can be too specific on these points, a great deal more careful work must be done upon all groups concerned.

In my collection there are between 20,000 and 25,000 insects which have been collected from the following states: Indiana, Wisconsin, Michigan, Iowa, Illinois, Pennsylvania, New York, Ohio, Minnesota, Missouri, Massachusetts, Mississppi, Alabama, Arkansas, Tennessee, Kentucky, Florida, Louisiana, Texas, North and South Carolina, New Mexico, Colorado, and California. I have also some collections from near Berlin, Germany, and many collections from the central and western parts of Mexico.

The following is the material upon which this study has been based:

Callimominæ: *Callimome, Diomorus, Ecdauma.*

Monodontomerinæ: *Monodontomerus, Zaglyptonotus, Ditropinitus,* and *Eridontomerus.*

Ormyrinæ: *Ormyrus* and *Monobaeus.*

Megastigminæ: *Megastigmus.*

Podagrioninæ: *Podagrion.*

I have been unable to include either the Idarinæ or the Erimerinæ because of lack of material. The latter group appears to be close to Monodotomerinae, and judging from published descriptions doubtfully possesses subfamily rank. The primary distinguishing feature of the Erimerinæ is the possession of one rather than two spurs on the hand tibia, and this of course may have originated through a single minor mutation.

PART 1. PHYLOGENETIC CONSIDERATIONS

In the recognition of phylogenetic relationships within this group, the following morphologic and biologic characteristics were employed:

Morphologic Characteristics:

1. The thorax: size in relation to the body; degree of fusion of plates; shape and sculpture.
2. The antenna: length in relation to the body; tendency toward, or absency of clubbing; relative size and shape of segments.
3. The abdomen: size of plates; distinctness of segmentation; presence or absence of the tendency for a petiole to develop; presence or absence of compression and sculpture; and general abdominal shape.
4. The ovipositor: length of the external parts of the ovipositor and the length of the ventral valves in comparison to the body; and in some cases, the tendency for the ovipositor to coil upon itself proximally.
5. The legs: whether or not the femora are enlarged, and the presence of absence of spines on the femora.

Biologic Characteristics:

1. Host relations: whether the insects are parasitic, phytophagous, or both, and the number of orders, families, and genera which constitute the hosts of each group.
2. Type of parasitism involved: upon which stage or stages of their hosts each group is parasitic, and the amount of restriction

shown by each group. Also whether the insects are primary or secondary parasites, or both.

Although the drawings here reproduced are primarily those of female structures, the observations have been taken from both male and female. The female insect was used in most cases because more structures were available for study, and in most instances, more females are represented in a series than males.

The Thorax

The thorax of even the most primitive of the Callimomidae is highly modified in comparison with that of some of the lower Hymenoptera.

In the sawflies, according to Snodgrass (1911), the thorax is rather loosely put together, and the three segments approach each other in size; although even in these primitive Hymenoptera the mesothorax is becoming larger. The postnotum of the meso- and sometimes of the methathorax, is distinguishable, and the pleura of these segments are divided by plural sutures into an epimeron and an episternum. The notum of the mesothorax is either a simple plate, or divided into an anterior and posterior part.

The thorax of the higher Hymenoptera which, according to Snodgrass, was derived from a thorax something like that found in the sawflies, has undergone extreme modification. In general the thorax of these higher Hymenoptera has become more compact by the dropping out of parts, although there has been an increase in size of the mesothorax. The postnotum of both meso- and metathorax has presumably become invaginated into the thorax. The notum of the mesothorax is modified by the formation of sutures; so that in some cases this may contain as many as five plates. The divided mesopleuron of the lower Hymenoptera becomes fused into a single plate in these higher groups, but in some cases there is a secondary suture developed which divides the pleuron into dorsal and ventral parts. An extra plate, the prepectus, is sometimes formed, which is probably derived from the mesopleuron and the mesosternum.

Because of this extreme modification of the chalcidoid thorax, there is current in the literature many misapplications of terms. One of these concerns a notch "above the middle on the mesepi-

sternum.'' This characteristic supposedly separates the Callimominae from the other subfamilies of the Callimomidae. In reality this notch is not on the mesepisternum, but on the mesepimeron, and there is no reason for the continuance of an error which apparently originated with Ashmead.

The following phylogenetic criteria were used in the present study of the thorax:

1. A thorax that is greatly shortened in proportion to the whole body length is specialized. Compression or flattening of the thorax is a specialization.
2. Fusion of sutures is an indication of specialization.
3. The presence of a secondary suture on the mesepimeron is possibly primitive in this family. It is present where the fusion of other sutures is at a minimum. I have designated the plate that this suture cuts off as the secondary epimeral plate.
4. Presence of well-developed sculpture or punctations is evidence of specialization.
5. A dorsally truncate pronotum is a specialized structure.
6. A greatly enlarged propodeum is a specialization. This structure represents the first abdominal segment which has become attached to the thorax.

Callimominæ: In *Callimome* (Fig. 5) the thorax is elongate with no decided tendency for shortening or flattening. The notum is not truncate dorsally, the secondary epimeral suture is definite, and there is practically no inclination for sutures to fuse. Some of the larger species possess definite punctations. In a few species, the thorax is somewhat humped, while in others, the parapsidal grooves show some inclination to fuse. The propodeum is of normal size.

In thoracic features, *Diomorus* is essentially the same as *Callimome*.

In *Ecdauma* (Fig. 6), however, modifications occur. The thorax is elongate and considerably flattened, and the propodeum is more enlarged. Excessive punctations are absent.

Callimone and *Diomorus*, then, seem to possess a comparatively primitive thorax, while in *Ecdauma* it is somewhat modified.

Monodontomerinæ: In all this subfamily, the secondary epimeral suture, although still distinguishable, becomes obscure. The

thorax is not especially reduced in proportion to the body, the parapsidal grooves are poorly developed in most genera, and the pronotum is somewhat truncate dorsally.

In all species of *Monodontomerus,* (Fig. 8) the propodeum is either striate or rugose, and there is extreme rugosity in one species. In this same species, the pleural suture is lost, but in other species this suture is evident. The thorax is humped in most species, while the propodeum is of uormal size and not truncate.

Zaglyptonotus (Fig. 12) differs from *Monodontomerus* primarily in the following: The pleural suture is evident, the thorax is not humped, and the propodeum is not excessively rugose.

In *Eridontomerus* (Fig. 10) and *Ditropinotus* (Fig. 11) a peculiar sculpture is present which is remarkably alike in both genera. The parapsidal grooves are somewhat more evident than in the other genera of this subfamily, while the pronotum dorsally is somewhat more truncate. The thorax of *Eridontomerus* is somewhat flattened, while in both genera the propodeum is truncate.

All these genera of the Monodontomerinæ seem somewhat modified in thoracic features.

Megastigminæ: The thoracic color of *Megastigmus* (Fig. 13) makes it difficult for one to detect poorly defined sutures. The parapsidal grooves are clear cut, and other sutures on the thoracic dorsum are evident. The pronotum of this genus is comparatively more enlarged dorsally than in any other genus of the family. Because of this enlarged pronotum and the normal sized propodeum, the thorax is not reduced in proportion to the whole body. The thorax is usually well arched, and seems to be somewhat compressed. The pleural suture is lost in some species, and the presence of a secondary epimeral suture is doubtful. This thorax seems to be some departure from the primitive type.

Ormyrinæ: The genus Ormyrus (Fig. 9) differs markedly from the previously described groups in thoracic characters. The parapsidal grooves are obscure in some species and entirely absent in others. There is no indication of a secondary epimeral suture, and although the pleural suture is evident, most of the other sutures show inclination to disappear. The propodeum

and pronotum are truncate, while the scutellum in many cases extends out over the propodeum. The thorax is extremely reduced in proportion to the whole body, and considerably humped.

While the above description applies primarily to *Ormyrus,* it will fit *Monobœus* with slight modification. In this genus, the parapsidal grooves while still obscure, are more evident than in most species of *Ormyrus.* However, the thorax is more humped.

The thoraces of this whole subfamily seem to be highly specialized.

Podagrioninæ: *Podagrion* (Fig. 7) likewise possesses a highly specialized thorax, but the specialization is quite different from that in the Ormyrinæ. The thorax is uniformily sculptured, the parapsidal grooves are faint to absent, and the presence of a secondary epimeral suture is doubtful. The pleural suture is absent, while the propodeum is enormously enlarged. Because of the enlarged propodeum, the thorax is elongate in proportion to the body. The thorax of *Podagrion* is also decidedly flattened.

Discussion of the thorax: From thoracic data alone, we have some guide as to the relationship between the different genera and subfamilies. *Callimome* and *Diomorus* are certainly closely related since these genera do not differ essentially in any thoracic character. *Ecdauma,* while obviously related to these two genera, is more modified.

All the genera of the Monodontomerinæ seem rather closely related with *Ditropinitus* and *Eridontomerus* possibly closer than any of the others. This whole subfamily seems related to the Callimominæ in the fact that the secondary epimeral suture is distinguishable in both groups, while in the other subfamilies it is barely discernible to absent. Evident parapsidal grooves (less evident in the Monodontomerinæ) may be other evidences of relationship between the two subfamilies, as is the medium sized propodeum found in both groups.

That *Megastigmus* (of the Megastigminæ) is related to the Callimominæ is evidenced by the following: The parapsidal grooves are clear cut in *Megastigmus* and in many species of the Callimominæ, the propodeum is medium sized in both groups, and the pronotum dorsally is elongate and not truncate.

Podagrion (Podagrioninæ) resembles Ecdauma (Callimominæ)

in possessing an elongate propodeum, and a thorax that is distinctly flattened. *Podagrion* has a sculpture that is remarkably similar to that in *Ditropinitus* and *Eridontomerus* of the Monodontomerinæ. In all the Monodontomerinæ and *Podagrion,* the pronotum dorsally is more or less truncate.

The Ormyrinæ do not seem to be closely related to any of the other groups in thoracic features, since the thorax is remarkably shortened, the parapsidal grooves are in most cases lost, sculpture is absent, and there is no sign of a secondary epimeral suture.

The Antenna

The antennæ of this family are quite variable, but in number of segments they are remarkably constant. All the antennæ have thirteen segments, but at times the distal three segments are hard to distinguish, presumably because of fusion. The first segment is commonly known as the scape, the second as the pecidel, and the invaribly small third segment as a ring joint. Sometimes the fourth segment is also reduced to the state of a ring joint. The more elongate segments which follow the ring joints, and make up the body of the antenna, constitute the so-called funicle. The funicle consists of seven segments unless there are two ring joints in which case there are only six segments in the funicle. The most distal three segments of the antenna form a club which may or may not be enlarged.

The second ring joint which is found in *Ormyrus* is clearly derived from antennal segment four (ordinarily a funicular segment). The number of antennal segments in the family as a whole can be considered constant only if the first ring joint is considered as segment three, and the next segment counted as number four, irrespective of whether it is a normal segment in the funicle, or reduced to a ring joint. In some species this second ring joint is considerably longer and somewhat wider than the first ring joint. In *Ditropinitus* and *Eridontomerus* of the Monodontomerinæ, the first funicular segment (antennal segment four) is smaller than the others, which shows another development of the same tendancy toward reduction in this segment. Since there is a tendency in many genera for the funicular segments to become reduced in size, it may be that the *first* ring joint was likewise derived from a funicular segment.

Antennal characteristics which seem to be of greatest phylogenetic importance are:

1. A definitely clubbed antenna is specialized.
2. An antenna whose funicular segments are notably wider than long departs from the primitive type, and is thus a specialized structure.
3. Greatly enlarged or greatly reduced segments indicate specialization.
4. Antennæ that are reduced in proportion to the body are specialized.
5. Funicular segments which are uniformly cylindrical for their entire length are probably primitive. At any rate, the shape of the funicular segments seems to indicate relationships.

Callimominæ: The antenna of *Callimome* (Fig. 14) is usually long in proportion to the body, and although there is sometimes a tendency for a slight club to develop in some species, this is always slight. The male does not exhibit this inclination as much as the female. The first funicular segment is usually slightly longer than the other segments of the funicle ,and the segments are longer than wide. The segments are uniformly cylindrical. In the male of some species, the funicular segments are somewhat quadrate.

This same description may be applied to *Diomorus* and *Ecdauma,* but since I possess only two specimens of *Ecdauma,* I cannot generalize too broadly. All these antennæ seem comparatively primitive.

Monodontomerinæ: *Zaglyptonotus* (Fig. 15) has an antenna that is essentially the same as that of the Callimominæ except that the segments are more nearly quadrate, and the antenna is shortened. No club is present, and the first funicular segment is slightly the longest of the funicle. The funicular segments are uniformly cylindrical, and subequal. The male antenna is essentially the same except that the funicular segments are more nearly quadrate.

The antenna of *Monodontomerus* (Fig. 19) is much the same as that of *Zaglyptonotus* except that it is not as much reduced in proportion to the body. The antenna of both these genera, while slightly specialized, seem comparatively primitive.

The antennæ of *Ditropinitus* and *Eridontomerus* are modified. In both genera the first funicular segment is the shortest of the funicle, being both shorter and narrower than the normal.

In the female of *Ditropinitus* (Fig. 21) the funicular segments are either wider than long or quadrate, and the segments get slightly wider from the proximal to distal end of the antenna. The segments are somewhat differentiated, each segment being constricted basally. There is no definite club present, but the funicular segments are loosely put together, and the terminal segments are more closely fused, which gives the impression of a club, especially in the female. The female antenna is greatly reduced in proportion to the body. In the male (Fig. 21) the funicular segments are more nearly quadrate, and the first funicular segment is not as much reduced in size as in the female.

In *Eridontomerus* (Fig. 20) the male and female antennæ are essentially alike, and highly specialized. A club is present, and all funicular segments are definitely wider than long. Each segment is constricted basally, and the segments become progressively wider toward the distal end of the antenna. The female antenna is reduced in proportion to the body.

Megastigminæ: The antenna of *Megastigmus* (Fig. 16) seems to be comparatively primitive. The male and female are essentially alike; all funicular segments are longer than wide, and are subequal. In some species, the first funicular segment is slightly the longest. No distinct club is present, but in some cases each end of the funicular segments are somewhat rounded. The antennæ are not essentially reduced, and they are relatively slender.

Ormyrinæ: The male and female of *Orymrus* (Fig. 18) present specialized antennæ which are essentially alike. Two ring joints are present, and the funicular segments are wider than long. The female antenna is reduced. Each segment of the funicle is constricted basally, and the terminal three segments are more closely fused so that one gets the impression of a club, although this is not greatly enlarged. Because of the reduction of the first funicular segment to a ring joint, the funicle is short in proportion to the scape.

In the female of *Monobæus* (Fig. 24) all segments are consider-

ably wider than long, segmental differentiation is extreme, and the antenna is reduced in length. No definite club is present, but as in *Ormyrus,* one gets the impression of a club. The first funicular segment is considerably shorter than the other funicular segments. The male antenna is essentially the same.

According to the original description of the genus *Monobœus,* only one ring joint is present. But the reduction of the first funicular segment is as great as in some (but not all) species of *Ormyrus.* The validity of the distinction of *Ormyrus* and *Monobœus* has been questioned, and although we must have more material to be certain of this, the character of the ring joints certainly breaks down on occasion.

Podagrioninæ: The female of *Podagrion* (Fig. 23) has an antenna with a much lengthened club, and because of this, the whole antenna appears long in proportion to the body. In the funicle, the first funicular segments are longer than wide, and subequal, but in the male (Fig. 22) the first segment is slightly longer than the others. In the female, the most distal of the funicular segments are quadrate. No definite club appears in the male.

In one species of *Podagrion* described by Gahan the club of the female antenna is as long as the whole funicle.

Because of this extreme tendency to club, the antenna of *Podagrion* seems to be greatly specialized. However, the absence of a club in the male is a primitive character.

Discussion of the Antenna: The antennal data taken alone supply some evidence of how these callimomid genera are related. All of the Callimominæ, and the genera *Zaglyptonotus, Monodontomerus,* (of the Monodontomerinæ) and Podagrion (Podagrioninæ) seem to have some relationships. In all these groups the first funicular segment is unreduced, and in most cases is the longest segment of the funicle. With the exception of the female of *Zaglyptonotus,* all of these have antennæ which are not essentially reduced in proportion to the body. In all of these groups, the majority of the funicular segments are longer than wide. The segments are poorly differentiated, so that the joints are hard to discern. In none of these groups, except the female of *Podagrion* is an enlarged club present, and the last three antennal seg-

ments in all the other genera are clearly the prototype of a club.

Megastigmus (Megastigminæ) with its reduced antenna, absence of a club, and the first funicular segment which is long in some species is probably related to the above named groups. The more slender antenna may indicate that it is not as closely related to the other groups on this character alone as they are to each other.

Eridontomerus and *Ditropinitus* of the Monodontomerinæ seem to be related. In the first named genus, and in the female of *Ditropinitus,* the first segment is distinctly the smallest of the funicle. In both genera, the antennæ are reduced, and segmental differentiation has taken place, especially in *Eridontomerus.* In *Eridontomerus* the funicular segments become widest toward the distal end of the antenna, and in the female of *Ditropinitus* there is a strong tendency toward this condition.

Ormyrus and *Monobæus* (Ormyrinæ) seem to be related. There are two ring joints in *Ormyrus,* and a decided tendency for the second ring joint to develop in *Monobæus.* In both, the female antenna is reduced, and segmental differentiation has taken place. All the funicular segments of *Monobæus* are wider than long, and this is true of most of these segments in *Ormyrus.*

Ditropinitus and *Eridontomerus* of the Monodontomerinæ seem to have some relationship to *Ormyrus* and *Monobæus.* All these genera have shortened antennæ, and the first funicular segment is the smallest of the funicle. As we shall point out later, however, we are not sure that these apparent relationships are significant.

The Abdomen

In the clistogastroid Hymenoptera, as is well known, the first true abdominal segment becomes applied to the thorax as the propodeum.

In the chalcidoids, the abdomen is sometimes long petiolate, but in most genera of the Callimomidæ, although there is petiole, it is not prominent.

Recent workers who have studied the morphology of the Callimomidæ and other families of the Chalcidoidea, (James 1926, and Grandi 1930), consider the petiole as a complete abdominal segment. Thus the *first* evident abdominal segment is the *third* true segment.

Counting the propodeum and petiole as true segments, there are nine dorsal plates or tergites in the abdomen of all Callimomidæ studied. However, only seven of these are applied to the abdomen proper, and the last one has become modified into the dorsal valves of the ovipositor. Only five true sternites are present in the abdomen proper. If other plates are present they have become considerably modified, and possibly applied to the ovipositor or male genitalia.

In this study the female abdomen was used primarily because the abdomen of the male is more uniform and shows a much greater tendency to shrink. More special structures are present on the female abdomen. In certain cases, however, the male abdomen may be employed to advantage, but unless specified otherwise, all the following descriptions will apply to the female.

The abdominal characteristics which seem to be of greatest phylogenetic importance are as follows:

1. Definite segmentation is more primitive than indefinite.
2. Dorsally incised tergites are specializations.
3. An abdomen with equal segmentation is more primitive than one with some segments enlarged or reduced.
4. An extremely compressed abdomen is specialized.
5. A petiolate abdomen is a specialized structure.
6. Species that have the male and female abdomen nearest alike in size and shape are more primitive than species with greater difference between the sexes.
7. An enlargement of one or more of the sternites is specialization.

It is probable that species in which the posterior sternites can be easily seen laterally are primitive, since this approaches the condition of the primitive abdomen. Likewise, an abdomen in which the sternites are pushed far anterior out of their normal position is presumably specialized. However, since all the abdomens show a certain shrinkage, only those cases in which the above points were extreme could be regarded as significant.

Callimominæ: The abdomen of *Callimome* (Fig. 26) is not excessively compressed or petiolate, although some species show this condition more than others. The abdomen is not elongate, and nearly as high as long. The male abdomen is considerably

smaller than the female. In the female, the third true tergite is greatly enlarged and overlaps the fourth, so that it sometimes can scarcely be seen on the mid-dorsal line, although it is more evident laterally. The third tergite is the largest dorsal plate, while the last three tergites are greatly reduced in size. The third and fourth dorsal plates are deeply incised on the posterior edge along the mid-dorsal line. Because of the thinness of the plates, the segmentation dorsally is poorly defined. The two anterior sternites, really sternite three and four, are greatly enlarged and overlap the tergites, and in some cases these are so enlarged that they extend for a great distance posteriorly. This is a remarkable development, not found in very many other Hymenoptera. In a few species the posterior sternites may be seen ventrally, but in others the sterna are enclosed within the tergites.

The above description of the abdomen may be applied to *Diomorus,* except that the anterior sterna are still more enlarged in some species.

Ecdauma (Fig. 30) has a very remarkable abdomen for a callimomid. It possesses a true petiole which is very elongate. At the same time it is very compressed. The sterna, however, may be seen ventrally. In other features it shows affinities with the other genera of the Callimominæ.

All these abdomens in the Callimominæ appear well specialized, with that of *Ecdauma* the most highly specialized.

Monodontomerinæ: The abdomen of *Zaglyptonotus* (Fig. 31) shows close affinities with *Callimome.* The third tergite is enlarged, incised, and overlaps the fourth. Sternites three and four overlap the tergites, although these are not as enlarged as in some species of *Callimome.* The abdomen is nearly as high as long, and the female abdomen is considerably larger than that of the male. The posterior tergites are reduced in size, while the sternites posteriorly are not visible. This abdomen seems to be specialized.

Monodontomerus, (Fig. 27) seems to possess a comparatively primitive abdomen. The segmentation is definite, the abdomen is not compressed or petiolate, the anterior tergites are not incised, although the third tergite overlaps the fourth in the male, and in the female the third tergite is somewhat reduced dorsally.

In one species, however, there is no reduction. The anterior sternites are enlarged only slightly. The male and female abdomen approach each other in size. The last tergites are reduced, and the abdomen is nearly as high as long.

In *Ditropinitus* (Fig. 29) the abdomen seems to be incipiently specialized. The segmentation is indefinite, the third and fourth tergites are incised, and the third tergite is not as enlarged as in the above genera. The anterior sternites are not enlarged, and the abdomen is not compressed or petiolate. The abdomen is considerably elongate and somewhat cylindrical. The size difference between the sexes is considerable.

Eridontomerus (Fig. 33) differs from *Ditropinitus* primarily in that the anterior tergites are not incised.

Megastigminæ: The abdomen of *Megastigmus* (Fig. 28) seems to be specialized. The abdomen is extremely compressed except in one species, and in this species the male abdomen is depressed and considerably petiolate. In most species, the sterna are all enlarged and these overlap the tergites. The third tergite is enlarged, and incised in all except one species. The last tergites are reduced in size, and segmentation is very indefinite. In most species, the male and female abdomen approach each other in size.

Ormyrinæ: In *Ormyrus* (Fig. 34) many species possess several rows of large punctations on the dorsal surface of the median tergites. The females vary somewhat in this feature, but the males almost invariably have these punctations. Dorsally, and part of the way down the sides, the third tergite completely covers the fourth, but further down, the segments are more nearly equal, and both third and fourth are evident. The abdomen is not compressed or petiolate, but in the female it is notably pointed, and cylindrical in shape. The male abdomen is decidely depressed. The tergites are not incised, and except where the large punctations interfere, the segmentation is definite.

In *Monobœus* (Fig. 38) the abdominal punctations are confined in many species to the anterior margins of the tergites, and since these are overlapped by the plates anterior to them, they cannot be seen externally. In the female, the eighth tergite is bent upward, so that the tip of the abdomen is noticeably tilted. Some species of *Ormyrus* exhibit this characteristic to a less degree.

In the female of *Monobœus,* all the sternites are crowded far anteriorly, so that the posterior one extends only to the fourth tergite. This is certainly a specialization, and since it is so extreme could not be accounted for by shrinkage. In other abdominal features, *Monobœus* shows close affinities with *Ormyrus.*

The abdomen of this subfaminly, then, while possessing some primitive features, certainly exhibits some peculiar specializations.

Podagrioninæ: The abdomen of *Podagrion* (Fig. 32) seems to be specialized. The female abdomen is extremely compressed, somewhat petiolate, and nearly as high as long. Tergites three and four are greatly enlarged dorsally, incised, and tergite three overlaps tergite four. The last two tergites are reduced in size. The anterior sternites overlap the tergites, and laterally tergite six is the largest plate of the abdomen. In the male, the first tergite and sternite proper are so enlarged that they both extend posteriorly for one half the length of the abdomen. In both male and female segmentation is indefinite while in the two sexes abdominal shape differs radically.

Discussion of the Abdomen. From abdominal data alone, we may reach some conclusions as to the relationships among the genera and subfamilies. The Callimominæ and the genera *Zaglyptonotus, Megastigmus,* and *Podagrion* seem to be related, since in all groups the female abdomen is either greatly compressed or exhibits a tendency toward compression. The anterior sternites overlap the tergites, and there is a tendency for a petiole to develop in all groups. The segmentation is indefinite, and tergite three is enlarged and overlaps tergite four. Both these plates are incised. All the abdomens are nearly as high as long. *Monodontomerus* (Monodontomerinæ) seems to be somewhat related to these groups, for the anterior sternites of this genus also show slight inclination to overlap the tergites, while the abdomen is again nearly as high as long. In all these groups, the posterior tergites are reduced in size.

Eridontomerus and *Ditropinitus* of the Monodontomerinæ show relationship, since in both genera the abdomen is cylindrical, considerably longer than high, and not compressed. In neither genus do the anterior sternites overlap the tergites.

Some indication that these genera may be related to the above groups is found in the indefinite segmentation, the somewhat reduced posterior tergites in both genera, and the incised tergites in *Ditropinitus*.

Ormyrus and *Monobœus* of the Ormyrinæ are certainly related to each other. The female abdomen is pointed, the segmentation is definite, the last tergites are not reduced in size, and the male abdomen is decidedly depressed. The anterior tergites are not incised, and the anterior sternites do not overlap the tergites. The peculiar abdominal punctations in *Ormyrus* are duplicated on the anterior part of the tergites in *Monobœus*. The Ormyrinæ do not seem to be closely related to any of the other groups in abdominal characteristics.

Female Genitalia

The genitalia of the Callimomidæ involve several sets of structures. The ovipositor proper includes the stylets and sheaths. Closely associated with the ovipositor are the dorsal valves which have presumably been derived from the ninth tergum. Hanna (1934) calls these plates the outer plates of Imms, which he states are the same as the quadrate plates of Snodgrass. The ventral valves are termed by Hanna the inner plates of Imms or the oblong plates of Snodgrass. These plates seem to have been derived from the ninth sternum. The fulcral plate of Imms, or triangular plate of Snodgrass, is according to James (1926) an expansion of the basal portion of each stylet. Hanna states that this plate has been derived from the eighth sternum. A thin chitinous plate arises from the dorsal proximal edge of each ventral valve. Grandi (1930), and according to Hanna in an earlier paper, has named this plate the falcate plate.

There is considerable variation among the genera in the length of the ovipositor outside the body, and in the length of the ventral valves. In some genera, there is a tendency for the ovipositor to coil upon itself anteriorly, while in others, the ovipositor and ventral valves outside the body are carried foward at an extreme angle.

The genitalic characteristics which seem of the most importance in phylogenetic interpretation are:

1. Greatly elongate ventral valves outside the body, since they are derived from a portion of a segment, are specialized structures.

2. Basal coiling of the ovipositor is a specialization.

3. External foward bending of the ovipositor and ventral valves as found in one genus is a specialization.

4. Extreme ovipositor length outside the body is a specialization.

5. Any especially enlarged portion of the genitalia whose origin is known to be from the portion of a segment, is evidence of specialization.

Callimominæ: In most species of *Callimome* (Fig. 35) the ventral valves and external ovipositor are as long as the body, and in some cases considerably longer. In only a few instances are these structures somewhat shorter than the body. The base of the ovipositor coils upon itself considerably in some species, but in others, this coiling is not as great. In all of the *Diomorus* that I possess the ovipositor and ventral values are as long or longer than the body, although some species have been described in which these structures are slightly shorter. Basally, the genitalia are essentially the same as in *Callimome.* In *Ecdauma* the ovipositor and ventral valves are nearly twice the length of the body. I did not have enough specimens to study the genitalia basally.

In these structures, all the Callimominæ seem well specialized.

Monodontomerinæ: In *Monodontomerus* (Fig. 42) the ventral valves and ovipositor outside the body are considerably shorter than the body. Basally there is not much coiling of the ovipositor, although more than in the following genus.

In *Ditropinitus* (Fig. 39) the ovipositor and ventral valves are very short, and in some instances even shorter than the abdomen. The ovipositor does not coil basally. Both the above genera seem primitive in genitalic features.

I did not possess enough material to study the genitalia basally in *Zaglyptonotus* and *Eridontomerus.* In the first named genus, the external ovipositor and ventral valves are as long as the body. In *Eridontomerus,* however, these structures are shorter than the abdomen. Thus on these features alone, *Eridontomerus* seems primitive while *Zaglypnotus* is somewhat specialized.

Megastigminæ: In some species of *Megastigmus* (Fig. 40) the external ovipositor and ventral valves are longer than the body, while in others these structures are shorter. Basally there is practically no coiling of the ovipositor. Both the dorsal and ventral valves, however, are strongly curved, and externally the ovipositor and ventral valves are curved forward at an extreme angle over the back. In some species of *Callimome* there is a slight tendency for this condition to develop, but the extreme condition seems to be confined to *Megastigmus.* This genus seems specialized in ovipositor features.

Ormyrinæ: In both *Ormyrus* (Fig. 41) and *Monobœus* (Fig. 37) the ventral valves and ovipositor hardly extend beyond the tip of the abdomen, although in *Monobœus* they are slightly longer than in *Ormyrus.* Correlated with this shortening of the ovipositor, the base is considerably coiled inside of the abdomen. This condition is more extreme than in any of the other genera, and should therefore be regarded as a specialization; although in a different manner than that found in other genera, where the specialization is found in extreme length development of the ovipositor outside of the body. This basal coiling is more developed in *Monobœus.* In both these genera, the falcate plate is comparatively much larger than in the other genera studied and the external parts of the ventral valves are greater in diameter. In these genera, then, specializations are present, but different from those found in other groups.

Podagrioninæ: In *Podagrion* (Fig. 36) those species which I examined possessed ovipositors and ventral valves somewhat longer than the body, although in some described species these structures may be slightly shorter. In a few species, these structures are over twice the length of the body, so that there seems to be a tendency here for extreme length development. Basally there is practically no coiling of the ovipositor. This geuns seems specialized, with some species of the extreme length of the ventral valves and external ovipositor highly specialized.

Discussion of the Ovipositor: Since in all the Callimominæ, and the genera *Zaglyptonotus* (Monodontomerinæ), *Megastigmus* (Megastigminæ) and Podagrion (Podagrioninæ) there is a tendency for the external ovipositor and ventral valves to be as long

as or longer than the body, these groups seem to be related. Extreme basal coiling of the ovipositor is not present in any of these groups. *Eridontomerus, Ditropinitus,* and *Monodontomerus* of the Monodontomerinæ seem to be related for in these genera the genetalic ctructures are considerably shorter than the body, and usually shorter than the abdomen. There is no extreme coiling in these genera. *Ormyrus* and *Monobœus* of the Ormyrinæ resemble the last named genera in having shorter ventral valves and ovipositors. But in these genera of the Ormyrinæ, this condition has an entirely different evolutionary significance, because the external shortening of the ovipositor is correlated with internal coiling which is high specialization.

Femora

In *Podagrion* the hind femur is very much widened and supplied with many large teeth. Indeed the structure is reminiscent of the digging legs of the mole crickets, and a near duplicate of the expanded femora of the Chalcididæ. This development in *Podagrion* is certainly a specialization.

In my collection there are several species presumably of the genus *Callimome* which possess very serrate and somewhat widened hind femora. Otherwise these species show the diagnostic characters of *Callimome.* This similarity of structure seems to indicate that *Callimome* and *Podagrion* are related.

Eridontomerus and *Ditropinitus* possess denticulate femora, which taken alone may indicate relationship between these two genera.

The genera *Diomorus, Ecdauma, Monodontomerus* and *Zaglyptonotus* have a single tooth on the hind femora, and this fact may be indicative of interrelations.

Host Relations

The following data were obtained in part from the literature, and in part from my own observations. The published data vary much need confirmation as to details, although they may give some indication of the biology of the group.

In dealing with the host relations of any of the families of the Chalcidoidea, many difficulties are encountered. Since the

family Challimomidæ is world-wide in distribution, reports of species and of their hosts have appeared in such obscure journals that we can make no pretense of havng a complete record of the published material. Then too, the classification of this as well as of the other families of the chalcidoids is so difficult that the published determination of the parasite or of the host, or of both the parasite and host are often incorrect. This is especially true of the older literature, but occurs often enough in the more recent literature because many of the reports of the parasite come from those who are not specialists in the classification of the group.

Probably the most difficult matter in dealing with host relationships is to determine whether a given insect is phytophagous, a mere inquiline, or a true parasite. If it is parasitic, it is not always clear which of the several insects with which it may be associated is the true host. Particularly is this true in dealing with parasites bred from cynipid or other galls where there may be a half dozen other families besides the true gall maker represented in the gall.

While the present summary of host relations is admittedly incomplete, most of the literature has been covered, and it is to be hoped that the most important references studied. When the original references were not available, Dalle Torre's volume in the Catalogus Hymenopterorum (Vol. 5) has been of help.

The following tables are designed to give a summary of the host relations of each genus.

So far as I can determine, *Ecdauma* has never been reported from any host.

Although the majority of the species of *Callimome* are parasitic upon Cynipidæ and Itonididæ, several species have been established as phytophagus, and many species have been reported from two and three orders. In one species of *Callimome* both parasitism and phytophagy have been reported.

Diomorus which parasitizes only Hymenoptera, seems more restricted.

It has been suggested that *Zaglyptonotus* parasitizes Curculionidæ, but to my knowledge this has not been definitely estab-

HOST DISTRIBUTION OF CALLIMOMINÆ

Callimomid parasites		Host		
Genus	Species with known hosts	Order	Family	No. of genera parasitized
Callimome	9	Coleoptera	Cerambycidæ	1
			Curculionidæ	3(?)
			Ipidæ	1
			Nitidulidæ	1
	82	Diptera	Itonididæ	13
			Tipulidæ	1
			Trypetidæ	4
	5	Homoptera	Aphidæ	—
			Chermidæ	1
			Cicadidæ	2
			Diaspididæ	1
	125	Hymenoptera	Argidæ	—
			Callimomidæ	2
			Chalcididæ	1
			Cynipidæ	30
			Eurytomidæ	3
			Tenthredinidæ	2
	6	Lepidoptera	Larentiidæ	1
			Pyralididæ	1
			Tortricidæ	2
	1	Orthoptera	Mantidæ	1
	10	Phytophagous	Conifers	1 or 2
			Dicotyledons	10
			Monocotyledons	1
Diomorus	13	Hymenoptera	Crabronidæ	1
			Cynipidæ	6
			Megachilidæ	1
			Pemphredonidæ	1
			Sphegidæ	1

HOST DISTRIBUTION OF MONODONTOMERINÆ

Callimomid parasites		Host		
Genus	Species with known hosts	Order	Family	No. of genera parasitized
	2	Diptera	Stratiomyiidæ	1
	1		Tachinidæ	6
		Homoptera	Chermidæ	1
		Hymenoptera	Anthophoridæ	1
			Apidæ	1
			Braconidæ	3
			Ceratinidæ	1
	7		Cimbicidæ	2
			Eulophidæ	1
			Ichneumonidæ	6
			Megachilidæ	3
Monodontomerus			Tenthredinidæ	2
		Lepidoptera	Lymantriidæ	4
			Lasiocampidæ	3
			Olethreutidæ	1
	7		Pieridæ	2
			Psychidæ	1
			Pyralididæ	1
			Tortricidæ	2
			Zygænidæ	1
	1	Diptera	Itonididæ	1
		Hymenoptera	Ichneumonidæ	1
Ditropinitus	1		Eulophidæ	1
			Eurytomidæ	2
Eridontomerus	1	Hymenoptera	Eurytomidæ	1

lished.[3] The series which I possess were bred from sunflower heads, and associated with curculionids.

Monodontomerus in two instances has been reported from seeds of plants, and these species may be phytophagous, although this

[3] Since the submission of this manuscript for publication, the writer has reared a species of *Zaglyptonotus* from the puparia of *Tephritis finalis* Loew., (Trypetidæ), Curran det.).

has never been established. At least one species of this genus has been definitely known to attack three orders, and many genera in each. Several species have been reported from two orders. As we shall see, however, many species of *Monodontomerus* are hyperparasitic, and it is possible that their true hosts are not what the published records summarized in the above table seem to show.

HOST DISTRIBUTION OF MEGASTIGMINÆ

Callimomid parasites		Host		
Genus	Species with known hosts	Order	Family	No. of genera parasitized
	1	Colepotera	Curculionidæ	1
		Diptera	Itonididæ	1
	5		Trypetidæ	2
	6	Hymenoptera	Cynipidæ	6
Megastigmus	2	Homoptera	Apiomorphidæ	1(?)
		Lepidoptera	Gelechiidæ	1
	4		Pyralididæ	1
			Tineidæ	1
			Tortricidæ	1(?)
		Phytophagous	Conifers	9
	29		Dicotyledons	8

The majority of the species of *Megastigmus* are phytophagous, but several species have been established as parasites, while two have been reported as both parasitic and phytophagous. Many of the phytophagous species occur on hosts of two or more genera, and at least one species has been reported from both a conifer and a dicotyledon. The same is true of some of the parasitic species.

Ormyrus seems to be primarily restricted to Cynipidae. Several species attack several genera within the Cynipidae, but only one species has been reported from both a Cynipid and Itonid host.

In many cases the genus of the mantid which was host of *Podagrion* was not determined, but in all authentic cases of parasitism, this genus has been reared only from mantid egg cases.

HOST DISTRIBUTION OF ORMYRINÆ

Callimomid parasites		Host		
Genus	Species with known hosts	Order	Family	No. of genera parasitized
		Hymenoptera	Chalcididæ	1
Ormyrus	30		Cynipidæ	14
	2	Diptera	Itonididæ	1
Monobæus	1	Hymenoptera	Cynipidæ	1

Method of Parasitism. Although the data upon the method of parasitism within the Callimomidae is indeed fragmentary considering the large number of species with known hosts, some generalizations may be made from a study of these few species. In the following tables, all species that have been adequately studied are listed, and their method of parasitism compared.

Since the genera *Syntomaspis* and *Torymus* are considered as synonyms of *Callimome,* all the above species presumably belong to the genus *Callimome. S. pubescens* and *S. elegans* have both been reported as phytophagous and parasitic, but it has been stated that these species are synonyms of *Callimone* (*Syntomaspis*) *druparum.*

Since some species of *Callimome* are seemingly able to adapt themselves to a variety of host conditions, they are presumably plastic in their method of parasitism and thus comparatively primitive. Data are not available for the method of parasitism in other genera of the Callimominæ.

From these fragmentary data, it seems that at least some species of *Monodontomerus* are hyperparasites, although they may also

HOST DISTRIBUTION OF PODAGRIONINÆ

Callimomid parasites		Host		
Genus	Species with known hosts	Order	Family	No. of genera parasitized
Podagrion	21	Orthoptera	Mantidæ	6

CALLIMOME (CALLIMOMINÆ)

Species	Host	Method of Parasitism and stage of host	Authority
C. iris	Mantid	Eggs	Picard 1930
S. oviperditor	Cicada	Feeds externally upon egg masses	Gahan 1927
T. nigricornis	Cynipid, etc.	Any stage, its own or other larvæ. Also hyperparasitic	Picard 1928
C. dorycnicola	Itonidid	Internal parasite of larvæ and pupæ	Muller 1870
Torymus sp.	Itonidid	Ectoparasite of larvæ and pupæ	Colizza 1928
Syntomaspis sp.	Cranberry fruit worm	Internal parasite of pupæ	Franklin 1916
Torymus sp.	Dendrolimus	Hyperparasite	Takagi 1925
S. druparum	Many genera of plants and some cynipids	Reported as both parasitic and phytophagous	Several authors

be primary parasites. Those other species that attack the pupæ of their hosts, may also be hyperparasites. However, since some species can seemingly adapt themselves to a variety of conditions, they must be considered primitive. No well founded data are available for other genera of this family.

Megastigminæ. As mentioned before, a few species of *Megastigmus* have been reported as both parasitic and phytophagous. A species of Megastigmus has been reported as bred from fly larvae, and another from the pupa of its host, but the data are too fragmentary to be used.

Ormyrinæ. I have been unable to find any reliable references to the parasitic habits of this subfamily.

Podagrioninæ. *Podagrion* has been reported only from mantid egg cases, and thus these parasites seem highly specialized.

Discussion of Host Relations: It is rather difficult to compare a genus with a large number of species with one that has

MONODONTOMERUS (MONODONTOMERINÆ)

Species	Host	Method of Parasitism and stage of host	Authority
M. æreus	Hymenoptera	Larvæ and pupæ	Muesebeck 1931
	Tachinidæ	Puparia	Muesebeck 1931
	Lepidoptera	Pupæ, normally ectoparasitic hyperparasite	Muesebeck 1931
M. dentipes	Pine moth	Hyperparasite	Seitner 1927
	Aporia, Pieris, Lasiocampa	Pupæ	Mayr 1874
	Nematus	Larvæ	Mayr 1874
M. nitidus	Anthophora, Chalicodoma	Pupæ	Mayr 1874
M. obsoletus	Aporia, Psyche	Pupæ	Mayr 1874
M. obscurus	Brachonid	Hyperparasite	Blair 1926

relatively few, since, other things being equal, the genus with the largest number of species might be expected to attack more hosts. However, in comparing two genera with approximately the same number of species, that genus which contains both parasitic and phytophagous species, since it can thus adapt itself to a variety of habits, may be considered more primitive than one containing only parasitic or only phytophagous species. Likewise, those genera which are parasitic upon many families and orders of insects, are physiologically more primitive than those which are more limited in their choice of hosts. The same can be said for the stage of host attacked. Those genera that are limited are presumably specialized.

The question of whether the habit of phytophagy or parasitism is the most recent has been discussed for many years. Gahan (1922) considers that the phytophagous habit is the most recent; that the ancestors of the chalcidoids were plant feeders, that parasitism then developed, and that the present day phytogous species are of recent origin, and derived from the preceding parasitic species. If this be true, I see no reason why this reversal of habits may not have taken place several times; and even in some instances why the original phytophagous or parasitic tendency

may not have been retained in some instances while a reversal was taking place in others. At any rate, it appears to me that in order to obtain conclusive evidence, one must work out each species separately, since a change of reactions in one group does not necessarily imply that other groups will likewise change.

Some species of *Eurytoma* show both parasitism and phytophagy during their life history. Gahan and Phillips (1927) seem to think that this represents a transition from parasitism to plant feeding. In a phylogenetic study of the Eurytomidæ, Bugbee (MS)[4] thinks that the evidence might be better interpreted as a very generalized physiological state, which seems to be able to adapt itself to either type of feeding; also that fixed parasitism and phytophagy may have emerged as two diverging evolutionary developments, rather than interpreting these species as transitional between parasitism and phytophagy.

The genus *Callimime* with its many species certainly does attack many diverse groups of insect and plants. There are many species that attack as many as three orders, and some species have been reported as both parasitic and phytophagous. Thus, although many species are specialized in their restriction to the Cynipidae and Itonididae, there are other species of *Callimome* that are certainly physiologically primitive. Likewise, some species attack the eggs of their hosts, others may attack several stages, and some species may be hyperparasites or primary, as well as external or internal parasites. Therefore, although some species of this genus seem to be physiologically specialized, there are others that are primitive.

Monodontomerus, although known from only a relatively few species, seems to be comparatively primitive, since the known species attack many host groups. Some of the species, however, may be somewhat restricted, since some are hyperparasitic and attack the pupae of their hosts. Some species have been reported from both larvae and pupae of their hosts, but since none have been reported from other stages, they may be somewhat specialized in stage of host attacked, when compared with some species of *Callimome.*

[4] Since the submission of the present paper for publication, Dr. Bugbee's manuscript has gone to press in the Bulletin of the Brooklyn Entomological Society, and will probably appear before this paper.

In number of hosts attacked, some species of *Megastigmus* seem to be somewhat primitive, since many are not generically restricted as to hosts, and some have been reported as both parasitic and phytophagous. The data are too incomplete for us to make assumptions as to the stage of host attacked.

The species of *Ormyrus* for the most part seem specialized in host relations. Only one species has been reported from two orders, and the majority of the species are confined to the Cynipidae. There are no data as to the stage of the hosts which are attacked.

Podagrion which seems to be strictly confined in the number of groups attacked, and in the stage of its host, is doubtless highly specialized.

Callimome with its many species shows some host duplication with every other genus of the Callimomidae which was studied. Because of the large number of species in *Callimome,* this may or may not be significant. The fact that parasitic and phytophagous species occur only in this genus and *Megastigmus* may indicate that these two groups have somewhat the same physiological tendencies and are related. *Podagrion* and *Callimome* may be somewhat related since a species of *Callimome* attacks mantid egg cases, and with the exception of this species and the Podagrioninae, no other group of the *Callimomidae* have ever been reared from this host. *Callimome* and *Monodontomerus* seem to be somewhat related, for species of both genera are hyperparasites and external parasites on occasion. Also both genera may attack the pupae of their hosts.

There are some other host duplicates among the genera, but at the present state of our knowledge it is impossible to say whether or not these are significant.

PART 2. PHYLOGENETIC POSITION OF GENERA

The detailed analysis of the morphologic structures and the biologic data which allow any interpretation of the phylogenetic position of the callimomid genera, have already been given in Part 1 of the present study. The following account is, therefore, a coordination of the earlier conclusions reached for each of the data studied.

Callimominae

Callimome: In thoracic and antennal features, this genus seems to be comparatively primitive, but in abdominal and ovipositor characteristics many specializations are present. In their parasitic behavior, some species seem to be restricted, but there are certainly some that are plastic in their reactions. Because of this combination of primitive and specialized features, it seems as though this genus retained many of its ancestral traits while it was specializing other characters. There are some more species within this genus than any other, and since such a variety of biologic reactions are exhibited among the species, it seems as though considerable evolution has taken place within the genus.

As has been pointed out, *Callimome* shows morphologic relationship to the genera *Megastigmus, Zaglyptonotus, Podagrion,* and to a less degree *Monodontomerus.* Considering the morphologic relationship, it is probable that the apparent biologic relationshlps between *Callimome* and the above genera may be significant.

Diomorus: This genus is certainly closely related to *Callimome,* and it is possible that we are not justified in separating these two genera. Species of this genus show the same general morphologic features and the same relations. In its parasitism, *Diomorus* seems somewhat restricted.

Ecdauma: Upon the basis of our limited material, no complete interpretation of this genus can be made. Only one or two species have been described. Judging from the material which I possess, this genus seems to be primitive in antennal features, and somewhat specialized in thoracic characteristics. The extreme length of the external ovipositor and ventral valves seem to be specializations. Because of the extremely petiolate abdomen (the only genus examined with a true petiole) I am inclined to place *Ecdauma* high in the scale of evolution. Although specialized in certain features, this genus still shows relationships to *Callimome* and *Diomorus* within the subfamily.

Huber (1927) does not consider *Syntomaspis* and *Torymus* as genera distinct from *Callimome.* I have so considered these genera in this study.

Monodontomerinæ

Monodontomerus: Morphologically, although this genus possesses slight specializations, it is comparatively primitive. It possesses comparatively few species, but it attacks a variety of hosts, and in this respect seems to be primitive also. Because of these data, I consider *Monodontomerus* as a comparatively primitive genus. As stated before, this genus shows morphologic relationships to the Callimominae. In addition it seems to be somewhat related to *Megastigmus* and *Podagrion.* *Monodontomerus* seems to be closer related to *Zaglyptonotus* than to any other of the genera studied within the Monodontomerinae. Some of the species of *Monodontomerus, Callimome,* and *Megastigmus* have the same hosts, and this taken in connection with the morphologic resemblances between the genera may be further indications of relationship.

Zaglyptonotus: Although this genus does not present any extreme morphologic specializations, neither does it possess any excessively primitive features, and should for these reasons be considered intermediate in position. *Zaglyptonotus* seems to be more closely related morphologically to *Monodontomerus* than to any other genus studied within the Monodontomerinae. It shows some morphologic relation to the Callimominae, *Megastigmus,* and *Podagrion.* Nothing is known of the biology of the genus.

Ditropinitus: This genus also seems to be incipiently specialized, although it does possess certain primitive features in the abdomen and ovipositor. As mentioned before, the group appears to be related to *Eridontomerus,* in antennal, abdominal, and thoracic features. With this in mind, the fact that both these genera parasitize *Harmolita* living in grass stems may be significant. Biologically, *Ditropinitus* seems to be somewhat plastic, although there are no phytophagous species known.

Eridontomerus: Thic genus possesses an antenna as greatly specialized as any genus studied. In other morphologic features, however, it presents both comparatively primitive and specialized characters. It is more closely related to *Ditropinitus* in both biologic and morphologic features, than to any other genus within the Monodontomerinae. Because of the small number of species

with known hosts, no conclusion can be made as to the biology of the genus.

In conclusion, since there are so much difference between the various genera of the Monodontomerinæ, considerable evolution has probably taken place within the subfamily.

Megastigminæ

Megastigmus. In antennal features, *Megastigmus* appears to be comparatively primitive, but in abdominal and ovipositor structures highly specialized. In the thorax both primitive and specialized characteristics are present. Biologically, since no great host restriction is shown, the genus is probably primitive. Since both parasitic and phytophagous species are present within the genus, considerable evolution has probably taken place within *Megastigmus.* Morphologically this genus appears to be related especially to the Callimominae, and to the genera *Zaglyptonotus, Podagrion,* and to a less degree to *Monodontomerus.* The presence of both phytophagous and parasitic species within *Callimome* and *Megastigmus* suggests biologic relationship between them. Certain host duplications are present between species of *Megastigmus* and *Monodontomerus,* and considering the morphologic resemblances between these genera, this fact is possibly significant.

Ormyrinæ

Ormyrus: With the exception of certain presumedly primitive abdominal structures, *Ormyrus* seems to be morphologically specialized. It also appears to be restricted in host relations. Thus I consider this genus as rather highly specialized in both morphologic and biologic features.

Monobæus: As before stated, this genus may not be separate from *Ormyrus.* In morphologic features, it is essentially the same as *Ormyrus,* and thus highly specialized. Since nothing of note is known of the biology of the genus, we are not justified in making assumptions.

Although the Ormyrinæ as a group show certain resemblances to *Ditropinitus* and *Eridontomerus* within the Monodontomerinæ, I do not believe that this is very significant, The two groups do not duplicate hosts. *Ditropinitus* and *Eridontomerus* seem to be

restricted to insects inhabiting grass, while the Ormyrinæ show decided preference for Cynipidæ. Then too, the Ormyrinæ possess so many specializations peculiar only to themselves, that I believe that this subfamily should be placed on a separate line of evolution apart from the other subfamilies. Since all the subfamilies presumably came from a common ancestor, certain resemblances are of course to be expected between all groups, but unless these resemblances are many and from a variety of sources, I do not believe we are justified in assuming close relationships.

Podagrioninæ

Podagrion: Considering all morphologic and biologic features, *Podagrion* seems to be a very specialized genus. No excessively primitive features are present morphologically, and biologically this genus seems to be by far the most specialized group. As has been pointed out before, *Podagrion* exhibits certain morphological affinities with other groups of the Callimomidæ, namely, the Callimominae, and the genera *Zaglypnotus, Megastigmus,* and to a less degree *Monodontomerus.* Considering the morphologic relationship between *Podagrion* and *Callimome,* the fact that a species of *Callimome* has been bred from mantid eggs suggests further connections between these genera. There are no other callimomids known from mantid eggs.

Before concluding a discussion of the phylogenetic position of the genera, a word should be said as to the evolution of the subfamilies. Since many relationships, both morphologic and biologic exist between the genera of the Callimominæ, Megastigminæ, Monodontomerinæ, and Podagrioninæ, this seems to indicate that all these subfamilies belong to the same phylogenetic line. At the present state of our knowledge, it is impossible to tell which subfamilies are most closely related. Considering the host connection between *Podagriron* and *Callimome,* and the fact that *Callimome* seems as close or closer to *Podagrion* morphologically than any other group, might indicate that the Podagrioninæ are closer related to the Callimominæ than to any other subfamily. The presence of both phytophagous and parasitic species in *Callimome* and *Megastigmus* lends evidence to the effect that the Callimominæ and Megastigminæ may be closely related.

Since the Ormyrinæ do not show close relationships to any of the other subfamilies, it is probable that this group separated from the main line of evolution considerably before the other subfamilies.

SUMMARY AND CONCLUSIONS

1. The characteristic which distinguishes the subfamily Callimominæ is a notch on the mesepimeron and not on the mesepisternum.

2. Evidences of relationship based on any single character are not at all dependable, but evidence derived from several sources, both morphologic and biologic, provides a sounder basis for recognizing relationships.

3. A genus in which the species attacks large numbers of insects, or one in which the species are both parasitic and phytophagous, is more primitive than a genus that is more restricted in its host reactions.

4. A genus that is limited to a single stage of host that it attacks, is more specialized than one that attacks many stages.

5. The subfamilies Callimominæ, Monodontomerinæ, Megastigminæ, and Podagrioninæ show interrelations among the genera, and thus seem to belong to the same evolutionary line.

6. The Ormyrinæ probably belong to a different phylogenetic line of evolution.

7. Considerable evolution seems to have taken place within the Monodontomerinæ.

8. All the Ormyrinæ seem to be comparatively specialized both morphologically and biologically.

9. *Podagrion* is highly specialized morphologically, and the most highly specialized genus biologically within the Callimomidæ.

10. Considerable evolution seems to have taken place within the genera *Callimome* and *Megastigmus*.

11. *Monodontomerus* is a comparatively primitive genus both morphologically and biologically.

12. The status of the genera *Diomorus* and *Monobœus,* based upon the currently used distinguishing characteristics, is questionable.

13. Since *Ecdauma* possesses the only abdomen within the Callimomidæ with a true petiole, it should be placed high in the scale of evolution.

14. *Eridontomerus* and *Ditropinitus* seem to be more closely related to each other than to any other genus within the Monodontomerinæ.

15. *Podagrion* and *Megastigmus* are possibly closer related to *Callimome* than to any other genus outside their own subfamily.

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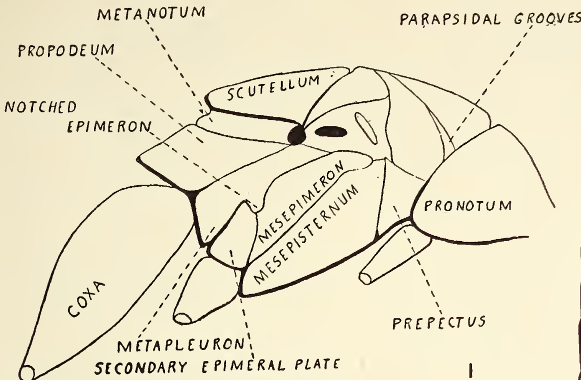
PLATE XXV

Structures of Callimomidæ showing principal parts

Figure 1. Thorax of Callimomidæ (Callimominæ)
Figure 2. Abdomen of Callimomidæ
Figure 3. Female genitalia of Callimomidæ
Figure 4. Antenna of Callimomidæ



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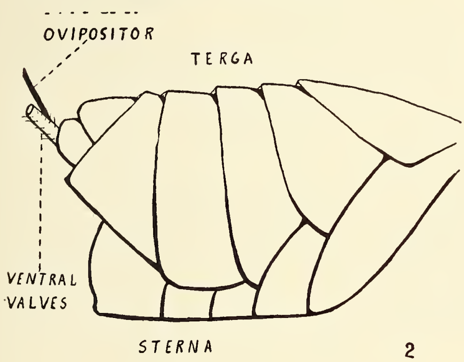

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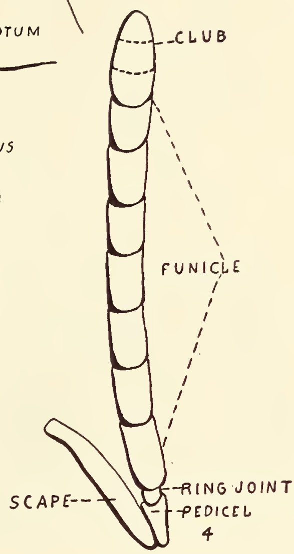

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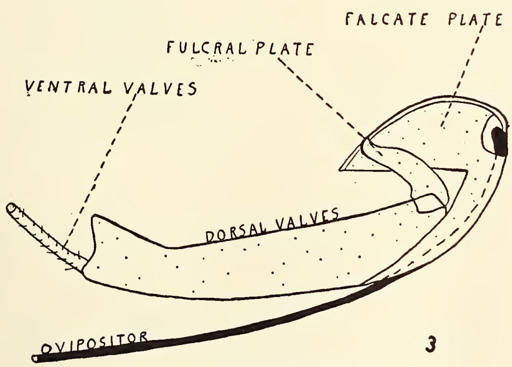


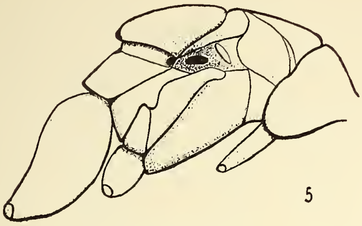
3

CALLIMOMIDÆ

PLATE XXVI

(From adults uniformly enlarged to 200 mm. so that the relative size of thoraces may be compared by direct comparison of thorax drawings).

Figure 5. Thorax of Callimome sp.
Figure 6. Thorax of Ecdauma sp.
Figure 7. Thorax of Podagrion sp.
Figure 8. Thorax of Monodontomerus sp.
Figure 9. Thorax of Ormyrus sp.
Figure 10. Thorax of Eridontomerus sp.
Figure 11. Thorax of Ditropinitus sp.
Figure 12. Thorax of Zaglyptonotus sp.
Figure 13. Thorax of Megastigmus sp.



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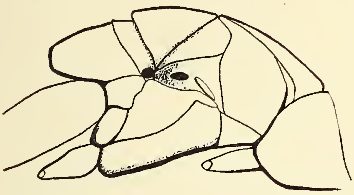

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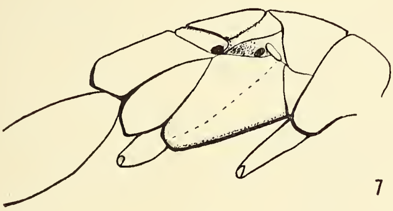

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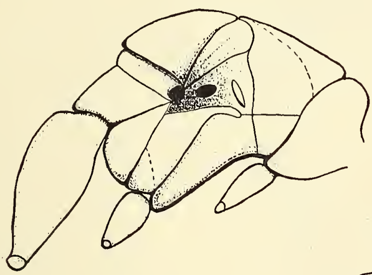

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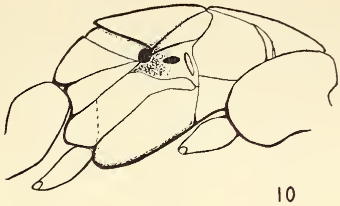

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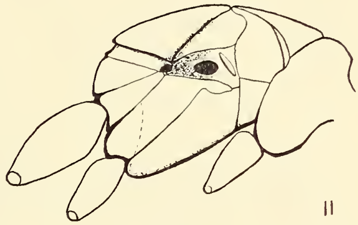

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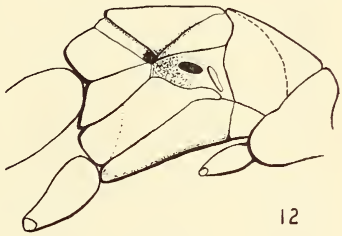

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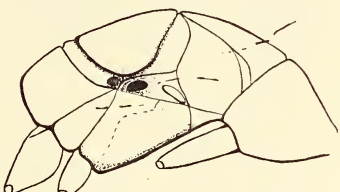

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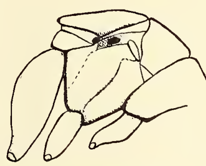


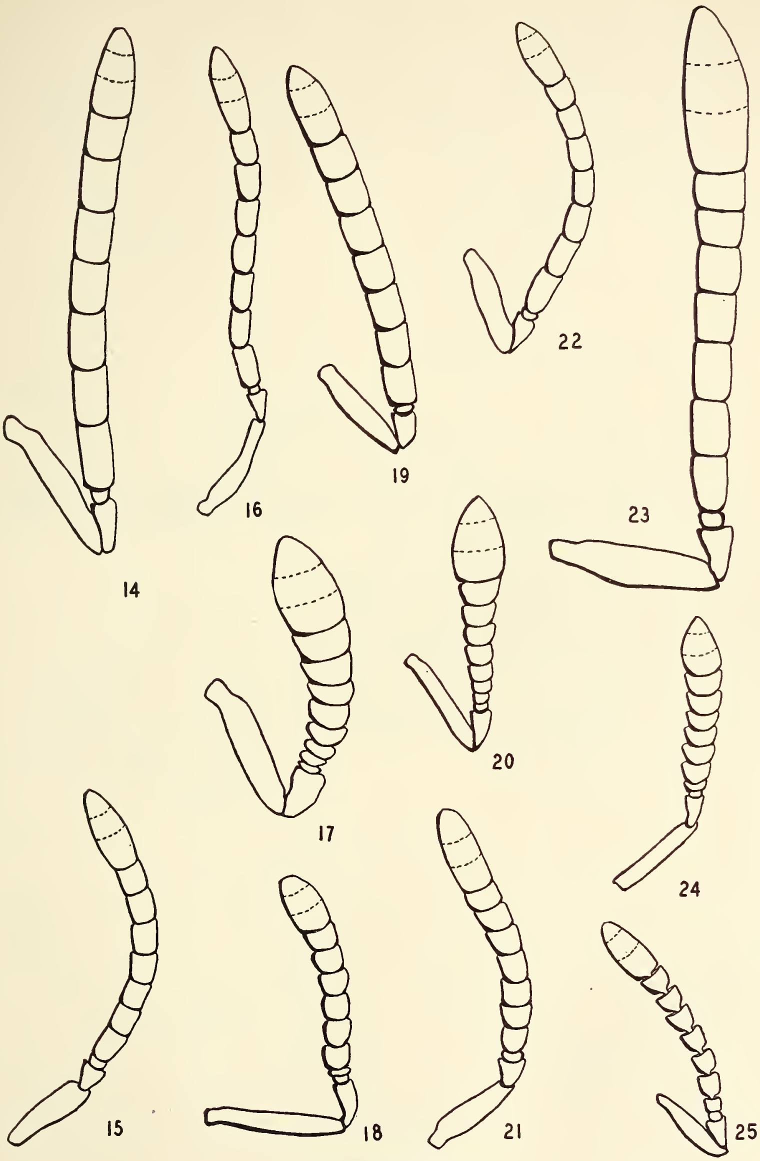
9

CALLIMOMIDÆ

PLATE XXVII

(From adults uniformly enlarged to 350 mm. so that the antenna-body ratio may be compared by direct comparison of drawings).

Figure 14. Antenna of female of Callimome sp.
Figure 15. Antenna of female of Zaglyptonotus sp.
Figure 16. Antenna of female of Megastigmus sp.
Figure 17. Antenna of male of Eridontomerus sp.
Figure 18. Antenna of female of Ormyrus sp.
Figure 19. Antenna of female of Monodontomerus sp.
Figure 20. Antenna of female of Eridontomerus sp.
Figure 21. Antenna of male of Ditropinitus sp.
Figure 22. Antenna of male of Podagrion sp.
Figure 23. Antenna of female of Podagrion sp.
Figure 24. Antenna of female of Monobaeus sp.
Figure 25. Antenna of female of Ditropinitus sp.

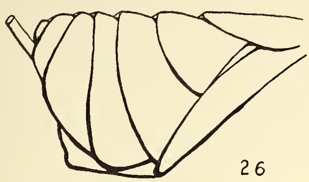


CALLIMOMIDÆ

PLATE XXVIII

(From adults uniformly enlarged to 200 mm. so that the relative size of the abdomen may be compared by direct comparison of abdominal drawings).

Figure 26. Abdomen of Callimome sp.
Figure 27. Abdomen of Monodontomerus sp.
Figure 28. Abdomen of Megastigmus sp.
Figure 29. Abdomen of Ditropinitus sp.
Figure 30. Abdomen of Ecdauma sp.
Figure 31. Abdomen of Zaglyptonotus sp.
Figure 32. Abdomen of Podagrion sp.
Figure 33. Abdomen of Eridontomerus sp.



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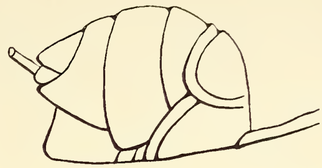

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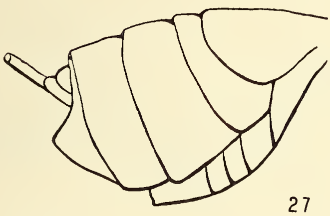

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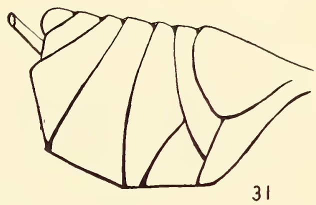

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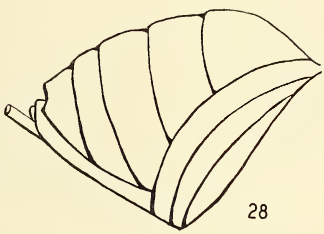

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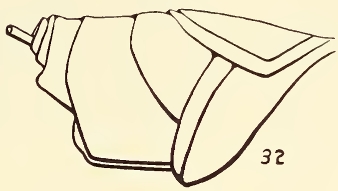

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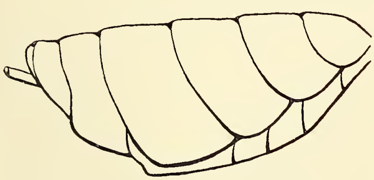

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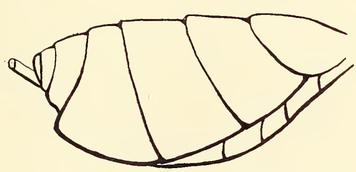

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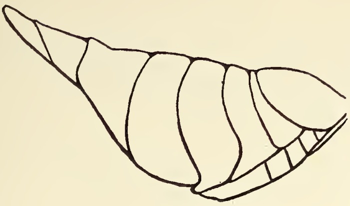
CALLIMOMIDÆ

PLATE XXIX

(Figs. 34 and 38 from adults uniformly enlarged to 200 mm. Other figures from adults uniformly enlarged to 125 mm. so that comparative size of parts may be compared by direct comparison of genitalic drawings).

Figure 34. Abdomen of Ormyrus sp.
Figure 35. Female genitalia of Callimome sp.
Figure 36. Female genitalia of Podagrion sp.
Figure 37. Female genitalia of Monobaeus sp.
Figure 38. Abdomen of Monobæus sp.
Figure 39. Female genitalia of Ditropinitus sp.
Figure 40. Female genitalia of Megastigmus sp.
Figure 41. Female genitalia of Ormyrus sp.
Figure 42. Female genitalia of Monodontomerus sp.



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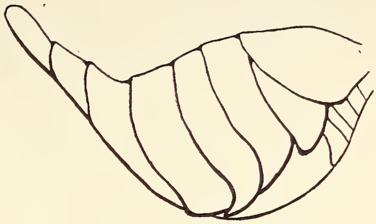

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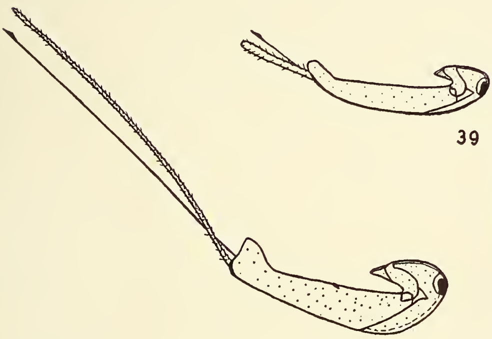

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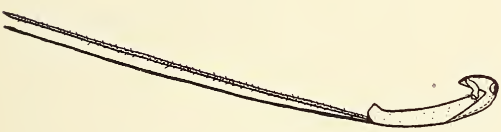

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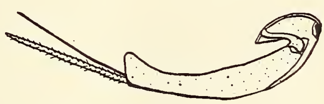

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CALLIMOMIDÆ

SEROLOGICAL INVESTIGATION OF DROSOPHILA ANTIGENS WITH THE COMPLEMENT FIXATION REACTION

By Russell W. Cumley and Sol Haberman
Department of Zoology, The University of Texas

Introduction

This investigation had its origin in a zoölogy seminar in January, 1936. The unpublished immunological works of Irwin and his associates regarding dove-pigeon hybrids, were under discussion. The suggestion was made that perhaps a similar study of *Drosophila* species would be of interest to geneticists and taxonomists. The question was discussed with Professor V. T. Schuhardt, who suggested that the ring-precipitin and complement fixation reactions should be tried. As a consequence of this conversation, Professor Schuhardt and R. W. Cumley initiated an immunization program, in order to determine roughly whether the formation of antibodies could be stimulated in rabbits in response to the injection of a *Drosophila* antigen. A rabbit was injected intraperitoneally, at three-day intervals, with 4 cc. saline suspensions of macerated bodies of *Drosophila melanogaster*. In the subsequent tests the complement fixation reaction was employed; and in these tests the antiserum to *Drosophila melanogaster* antigen yielded complement fixing antibodies in an antiserum dilution of 1:320, when tested against its homologous antigen. Heterologous test antigens made from two other species of *Drosophila* gave titres of 1:160 and 1:80, respectively.

During the following spring and summer T. A. Koerner and R. W. Cumley inoculated several rabbits intravenously with suspensions of macerated flies, in dilutions of 1:100, and in doses ranging from 1.0 to 25.0 cc. Several rabbits died, and no significant results were obtained. These initial studies were of considerable importance, however, since they defined certain limits regarding the size of the antigenic dose.

In July, 1936 Levit *et al.* announced their results in detecting the presence of the Y-chromosome in males and attached–X

females of *Drosophila melanogaster,* through the use of complement fixation methods (Levit, Ginsburg, Kalinin, and Feinberg, 1936). Although they did not present the details of their technics, they confirmed the belief in this laboratory that antibodies to *Drosophila* could be demonstrated.

In October, 1936 R. W. Cumley and Sol Haberman* initiated another series of inoculations. The males and females of the following species were separated: *Drosophila bipectinata, D. caribbea, D. hydei, D. melanogaster, D. mulleri,* and *D. virilis.* The flies were macerated, and saline was added in the proportion of one gram of the fresh fly material to 50 cc. of 0.85% NaCl. After the mixture remained for two days in the ice box, it was filtered through several thicknesses of filter paper. Rabbits were injected intravenously at about three-day intervals with a total of eleven doses of this filtered broth. The doses were of increasing size, beginning with 0.2 cc. of a 1:1000 dilution and proceeding to 0.4 cc. of a 1:50 dilution. Subsequent tests showed that no appreciable antibody formation occurred from the injection of such small doses. The animals were then inoculated with five larger doses, in accordance with Professor Schuhardt's views, and as had been suggested by the first inoculations which he and Cumley had made. These doses ranged from 2 cc. of a 1:50 dilution to 4 cc. of a 1:50 dilution. A trial bleeding of a few cubic centimeters was made six days after the last injection. The blood showed the presence of complement-fixing antibodies, and the animals were bled from the heart two days later.

In the subsequent complement fixation and precipitation tests low dilutions of complement-fixing antibodies and confusing results were the rule. From these experiments the conclusions were drawn that (1) more exact methods of standardization of antigens should be used; and (2) a more concentrated antigen, prepared from dried flies, would be necessary. This last conclusion is contrary to the findings of Brown and Heffron (1928), in their serological investigations of Lepidoptera; they reported that precipitating antibodies were produced in greater quantity when the fresh material, rather than the dried, was used as antigen.

* Mr. Haberman served in the capacity of technical assistant, and was paid from the research fund of the Department of Zoology.

Materials and Methods

The results reported in this paper were obtained from testing the sera of rabbits which had been immunized to saturated saline solutions of dried flies. Martin and Cotner (1934) successfully immunized rabbits to moth species by using similarly prepared antigens. In the present experiments the following species of *Drosophila* were employed: *bipectinata, caribbea, hydei, melanogaster,* and *virilis.* The flies were grown in half-pint milk bottles, on the yeast-banana agar used in routine genetical experiments. Usually, the flies were removed from the food within two days after hatching. After being weighed, they were macerated in a mortar. The pasty material contained in the mortar was desic-

TABLE 1

Sample	*Drosophila* Species	Weight before drying	Weight after drying	Per cent water	Per cent dry powder
1	*virilis*	17.76 grams	5.74 grams	67.7	32.3
23	*virilis*	23.78 "	6.34 "	73.3	26.7
25	*virilis*	41.36 "	9.27 "	77.6	22.4
2	*caribbea*	27.04 "	6.92 "	74.4	25.6
7	*caribbea*	25.93 "	6.82 "	73.7	26.3
22	*caribbea*	19.89 "	4.76 "	76.1	23.9
24	*caribbea*	37.15 "	8.75 "	76.4	23.6
3	*hydei*	8.63 "	2.30 "	74.3	25.7
10	*hydei*	11.86 "	3.28 "	72.4	27.6
18	*hydei*	21.31 "	4.84 "	77.3	22.7
4	*melanogaster*	21.15 "	6.12 "	71.1	28.9
16	*melanogaster*	31.86 "	8.17 "	74.4	25.6
26	*melanogaster*	11.40 "	3.32 "	70.9	29.1
5	*mulleri*	22.65 "	8.19 "	63.9	36.1
11	*mulleri*	9.25 "	3.37 "	63.5	36.5
15	*mulleri*	6.83 "	2.26 "	66.9	33.1
20	*mulleri*	11.25 "	3.13 "	72.3	27.7
6	*sulcata*	9.55 "	3.14 "	67.0	33.0
12	*bipectinata*	12.62 "	3.44 "	72.7	27.3
17	*bipectinata*	32.63 "	7.67 "	76.5	23.5
21	*bipectinata*	23.92 "	5.67 "	76.3	23.7
14	*funebris*	29.17 "	8.43 "	71.1	28.9

cated *in vacuo* over sulfuric acid for two days. The material was removed, ground still more, and returned to the desiccator for further drying. When the powder was thoroughly dry, it was removed and weighed. No attempt was made to insure complete removal of the water, since the nitrogen content of the samples was to determine their ultimate standardization. Table 1 shows data regarding the weights of several species of *Drosophila* before and after drying. The percentages of water removed in desiccation, by this method, varied from 63.5% to 77.6%.

The powdered flies obtained by desiccation and grinding were mixed with 0.85% NaCl in the ratio of 1 gram of fly powder to 10 cc. of saline. The mixture was allowed to remain in the ice box at about 9 degrees Centigrade for two days. The broth was then centrifuged and the clear supernatant solution decanted. This solution was filtered through several thicknesses of filter paper and preserved with Merthiolate Solution (1:10,000). Table 2 presents data relating to the preparation of the saline extracts. From this table one may note that the amount of fly powder which will go into solution per cubic centimeter of saline varies considerably from sample to sample. In order to have standardized the antigens on the basis of weights of materials, one would have had to consider the weight of the material extracted.

The clear saline extract taken directly from the powder was used for immunization of the animals. Rabbits were inoculated seven times with doses increasing from 1 cc. to 4 cc. of the above described solution. These injections were rather irregular, since several trial bleedings were made at intervals to determine the presence of complement-fixing antibodies. The inoculations made several of the rabbits extremely sick, and six of them died in the course of the immunization. Seven days after the seventh injection the rabbits were bled from the heart, without anaesthesia, The amount of blood taken from each rabbit varied from 8 cc. to 30 cc.

In the complement fixation reactions serial dilutions of the antisera were made, and all the antigens were tested against a particular antiserum. No attempt was made to standardize the protein content or antibody content of the antisera. The test antigens, however, were standardized. Micro-Kjeldahl tests were

TABLE 2

Sample number	*Drosophila* Species	Grams of dried powder	Cc. of saline added	Cc. of extract removed	Grams of dissolved material in extract	Grams of undissolved residue	Dilution of antigen extract: gm./cc.
1	*virilis*	3.00	30.00	23.00	0.655	2.345	1: 34.5
1	*virilis*	2.74	27.40	21.00	0.790	1.950	1: 26.6
2	*caribbea*	3.00	30.00	22.00	0.835	2.165	1: 26.4
3	*hydei*	2.29	22.90	16.00	0.755	1.540	1: 21.2
10	*hydei*	3.27	32.70	24.00	1.275	2.000	1: 18.8
4	*melanogaster*	4.00	40.00	30.00	0.975	3.025	1: 30.8
5	*mulleri*	4.00	40.00	34.00	1.875	2.125	1: 18.1

run on each of the various antigen extracts, and the solutions were adjusted to have equivalent nitrogen contents. The nitrogen contents of the saline extracts of dry flies and the saline extracts of wet flies, mentioned earlier in this paper, are shown in Table 3. One may observe that the nitrogen contents of the samples vary considerably, rendering the adjustment for nitrogen equivalence imperative. As is revealed in this table, the nitrogen

TABLE 3

Fresh flies. Extracted 1: 100 in saline	
Drosophila Species	Mgm. of nitrogen per cc. of extract
melanogaster	0.0470
virilis	0.0420
simulans	0.0429
pseudoobscura A	0.0384
miranda	0.0464
Dried flies. Extracted 1: 50 in saline	
Drosophila Species	Mgm. of nitrogen per cc. of extract
melanogaster	1.2200
mulleri	0.6960
hydei	0.6370
virilis	0.7280
caribbea	0.6870
bipectinata	1.1680

contents of the 1:50 extracts of the dried flies are from fifteen to twenty-five times as great as those of the 1:100 extracts of the fresh flies, a fact which probably accounts for the increased antigenicity of the dried fly extracts.

The antigens which were to be used for the tests were first tested to determine whether they possessed properties which would inhibit or interefere with the normal action of the complement, *i.e.*, whether the *Drosophila* antigens possessed active anticomplementary agents. The results of this test are shown in Table 4. Since a two-plus (++) reaction took place in the 1:2400 dilution of the *D. hydei* antigen, all the antigens were diluted to

TABLE 4

Type of Antigen	Dilution of Antigen										
	1: 50	1: 100	1: 150	1: 200	1: 300	1: 400	1: 600	1: 800	1: 1200	1: 1600	1: 2400
Melanogaster	++	−	−	−	−	−	−	−	−	−	−
Mulleri	++++	+++	+++	++	+++	++	+	+	±	±	±
Virilis	++++	++	+	−	−	−	−	−	−	−	−
Caribbea	+++	++	+	±	±	±	−	−	−	−	−
Hydei	++++	++++	++++	++++	++++	++++	++++	+++	+++	++	++
Bipectinata	++++	++++	++++	++++	+++	+++	++	+	−	−	−

1:5000 before proceeding with complement fixation tests. Consequently, the antigens were diluted to a point considerably beyond the range in which anticomplementary activity occurred.

The standard complement fixation reaction was used in testing for the presence of complement-fixing antibodies in the sera of immunized rabbits. The antisera were diluted serially, and the antigens were held constant. Complete hemolysis in any given tube was recorded as negative (–). Complete lack of hemolysis was recorded as positive (++++) complement fixation. Three intermediate grades of fixation were recorded as one-plus (+), two-plus (++), and three-plus (+++), on the basis of relative amounts of hemolysis.

RESULTS

In order to determine roughly the end-points of complement fixation, a series of tests were run in which the various antisera were tested against their homologous antigens. The results of these tests are shown in Table 5. From the titres recorded in these tests, the dilutions of antisera which were to be used in heterologous tests were indicated. The heterologous tests yielded the results that are shown in Table 6. From this table the following features may be noted:

1) There is great variability in antibody production by rabbits immunized to the same antigen. Not only do different rabbits yield sera which differ in their antibody content, but the order in which the various antigens react with a given serum varies slightly from one rabbit to another. This may be attributed to individual differences of rabbits, to errors in reading the tests, and to errors inherent in the use of unpurified antigens.

2) There is a lack of reciprocal relations between antisera and antigens. In general, the order of relationships is the same, but the percentage relationships, as revealed in Table 7, varies considerably in the reciprocal tests. This question of reciprocity will be dealt with in detail in a subsequent paper. Reciprocity is not believed to be a necessary adjunct to the antigen-antibody relationship.

Table 7 presents the antigen-antiserum relationships that have been calculated from the data of Table 6. In calculating these relationships, modifications of the methods of Boyden (1926,

TABLE 5

Type of Antiserum	Type of Antigen	Dilution of Antiserum									
		1: 30	1: 40	1: 60	1: 80	1: 120	1: 160	1: 240	1: 320	1: 480	1: 640
Mulleri 3	Mulleri	++++	++++	++++	+++	+	−	−	−	−	−
Mulleri B5	Mulleri	++++	++++	++++	++	±	−	−	−	−	−
Mulleri 4	Mulleri	++++	+++	+	+	−	−	−	−	−	−
Mulleri B6	Mulleri	++++	++++	+	+	−	−	−	−	−	−
Virilis A4	Virilis	++++	++++	++++	+	−	−	−	−	−	−
Caribbea C1	Caribbea	++++	++++	++++	+	+	−	−	−	−	−
Caribbea C4	Caribbea	++++	++++	++++	++++	+	+	−	−	−	−
Melanogaster A1	Melanogaster	++++	++++	+++	+++	++	++	−	−	−	−
Melonagaster B1	Melanogaster	++++	+++	+	−	−	−	−	−	−	−

TABLE 6

Type of Antiserum	Type of Antigen	Dilution of Antiserum										
		1: 10	1: 20	1: 30	1: 40	1: 50	1: 60	1: 80	1: 100	1: 120	1: 160	1: 200
Mulleri 3	Mulleri		++++	++++	++++	++++	++	+	–	–	–	–
	Virilis		++++	+++	+	+	–	–	–	–	–	–
	Hydei		++++	++	–	–	–	–	–	–	–	–
	Caribbea		++++	+	–	–	–	–	–	–	–	–
	Bipectinata		+	–	–	–	–	–	–	–	–	–
	Melanogaster		–	–	–	–	–	–	–	–	–	–
Mulleri B5	Mulleri	++++	++++	++++	++++	++++	++++	+++	++	+++	+++	
	Virilis	++++	++++	++++	++++	++++	+++	++	+	+	–	
	Hydei	++++	++++	++++	++++	++++	+++	++	+	+	–	
	Caribbea	++++	++++	++++	++++	+++	+++	++	+	–	–	
	Bipectinata	++++	++++	++++	++++	+++	++	+	–	–	–	
	Melanogaster	++++	++++	++++	+++	++	++	+	–	–	–	
Mulleri 4	Mulleri	++++	++++	++++	+++	+	+	+	–	–	–	
	Hydei	++++	++++	++++	++++	+++	+++	–	–	–	–	
	Caribbea	++++	++++	++	–	–	–	–	–	–	–	
	Virilis	++++	+++	+	–	–	–	–	–	–	–	
	Bipectinata	–	–	–	–	–	–	–	–	–	–	
	Melanogaster	–	–	–	–	–	–	–	–	–	–	
Mulleri B6	Mulleri	++++	++++	++++	++++	++	+	+	–	–	–	
	Virilis	++++	++++	+	–	–	–	–	–	–	–	
	Caribbea	++++	+++	+	–	–	–	–	–	–	–	
	Hydei	++++	++	–	–	–	–	–	–	–	–	
	Bipectinata	++	+	–	–	–	–	–	–	–	–	
	Melanogaster	–	–	–	–	–	–	–	–	–	–	
Virilis A4	Virilis	++++	++++	++++	+++	+++	+	–	–	–	–	
	Mulleri	++++	++++	+++	++	+	–	–	–	–	–	
	Caribbea	++++	++++	++++	++	–	–	–	–	–	–	
	Hydei	++++	++++	++	–	–	–	–	–	–	–	
	Bipectinata	++	–	–	–	–	–	–	–	–	–	
	Melanogaster	+	–	–	–	–	–	–	–	–	–	

TABLE 6—(*Concluded*)

Type of Antiserum	Type of Antigen	Dilution of Antiserum										
		1: 10	1: 20	1: 30	1: 40	1: 50	1: 60	1: 80	1: 100	1: 120	1: 160	1: 200
Caribbea C1	Caribbea	++++	++++	++++	++	+	−	−	−	−	−	
	Mulleri	++++	+++	+	+	−	−	−	−	−	−	
	Virilis	++++	++	+	+	−	−	−	−	−	−	
	Hydei	++++	++	+	−	−	−	−	−	−	−	
	Bipectinata	+++	++	+	−	−	−	−	−	−	−	
	Melanogaster	+++	+	+	−	−	−	−	−	−	−	
Caribbea C4	Caribbea		++++	++++	++++	+++	++	++	+	−	−	−
	Mulleri		+++	++	+	+	−	−	−	−	−	−
	Virilis		+++	+++	+	−	−	−	−	−	−	−
	Bipectinata		+++	+	+	−	−	−	−	−	−	−
	Hydei		+++	+	−	−	−	−	−	−	−	−
	Melanogaster		++	−	−	−	−	−	−	−	−	−
Melanogaster A1	Melanogaster		++++	++++	+++	+	+	+	−	−	−	−
	Caribbea		++++	+++	++	+	+	−	−	−	−	−
	Hydei		++++	+++	++	+	+	−	−	−	−	−
	Mulleri		++	++	+	−	−	−	−	−	−	−
	Bipectinata		+	+	−	−	−	−	−	−	−	−
	Virilis		+	−	−	−	−	−	−	−	−	−
Melanogaster B1	Melanogaster	++++	+++	+	−	−	−	−	−	−	−	
	Caribbea	+++	+++	+	−	−	−	−	−	−	−	
	Mulleri	++	+	+	−	−	−	−	−	−	−	
	Virilis	++	+	−	−	−	−	−	−	−	−	
	Hydei	+	−	−	−	−	−	−	−	−	−	
	Bipectinata	−	−	−	−	−	−	−	−	−	−	

TABLE 7

Type of Antiserum	Type of Antigen	Percentage Antigen-Antiserum Relationship: highest dilution of reaction (Boyden)	Percentage Antigen-Antiserum Relationship: total number of pluses (Nelson & Birkeland)
Mulleri	Mulleri	100.00	100.00
	Virilis	55.20	55.10
	Hydei	55.20	48.30
	Caribbea	44.80	47.10
	Bipectinata	Less than 38.90	Less than 29.00
	Melanogaster	Less than 50.00	Less than 50.00
Virilis	Virilis	100.00	100.00
	Mulleri	83.40	70.00
	Caribbea	66.60	70.00
	Hydei	50.00	50.00
	Bipectinata	16.70	10.00
	Melanogaster	16.70	5.00
Caribbea	Caribbea	100.00	100.00
	Mulleri	65.00	47.50
	Virilis	60.00	44.20
	Bipectinata	50.00	35.90
	Hydei	45.00	33.40
	Melanogaster	40.00	21.70
Melanogaster	Melanogaster	100.00	100.00
	Caribbea	87.50	80.60
	Mulleri	75.00	42.90
	Hydei	54.20	45.60
	Virilis	45.80	22.32
	Bipectinata	Less than 37.50	Less than 14.30

1932, 1934) and of Nelson and Birkeland (1929) have been used. These authors worked with precipitation technics; their computing formulæ have been applied herein to the complement fixation reaction. The values were calculated on the basis of the highest dilution of reactivity and on the basis of the total number of pluses, *i.e.*, the strength of reactivity. These figures should not be interpreted as representing the relations that exist between the fly species, or as representing the actual percentage of likeness or unlikeness between any two species. Rather they show the extent to which several antigens react with a given antiserum, when compared with the homologous antigen-antibody reaction. For example, the *virilis* antigen reacts with the *virilis* antiserum at a dilution arbitrarily designated as 100%, whereas *mulleri*

antigen reacts at a dilution only 83.4% as great, and *melanogaster* antigen reacts at a dilution only 16.7% as great as the dilution at which the *virilis* antigen reacted. The chief value of these percentage relationships is that they indicate the serological ranks assumed by the various antigens.

Discussion

The reliability of these data is dependent upon several factors, of which a few will be considered. The standardization of the various reagents is of paramount importance. In this work the antigens were standardized in the manner previously mentioned. The amboceptor and complement were properly titrated, and controls for the amboceptor, complement, and sheep cells were carried with each set of tests. The antisera were considered variables; the antigens were accepted as constants. Several authors have suggested more exact standardization procedures, including lipoid extraction of antigens (Boyden 1936; Moritz 1934; Becker 1932), globulin extraction of antigens (Nelson and Birkeland 1929), determination of protein and nonprotein nitrogen content of antigens (Boyden 1934; Eisenbrandt 1936), and the use of buffered saline (Boyden 1926). The value of these presumably more exact procedures becomes evident only after tests have been made with the native unaltered antigens. This paper treats only of these latter materials. Other methods will be discussed in later publications.

As an antigen *Drosophila* presents inherent difficulties which possibly bear upon the reliability of these tests. The intestinal contents of the flies should be eliminated from the antigens. Several months of intensive effort failed to yield bacteria- and yeast-free flies in quantities large enough for making antigens. Some success has been attained in producing flies relatively free of food and yeasts.

Another factor which should influence the reliability of these tests is the possible presence of natural antibodies to *Drosophila* in the serum of the rabbits. All of the rabbits used in this investigation were found to be free of any such natural antibodies. Furthermore, three control animals were tested. Two of these animals had never been immunized to foreign material. The third

had been immunized previously to staphylococci. The two unimmunized animals showed no complement-fixing antibodies; while the third showed the presence of complement-fixing antibodies in low dilutions. This may be explained as a nonspecific reaction due to sharing of antigen complexes or to the presence of similar antigenic factors in both *Staphylococcus* and *Drosophila,* or to the presence of staphylococci in or on the drosophilas used as the test antigen.

CONCLUSION

The complement fixation reaction can be used in differentiating the antigens of various *Drosophila* species. The results of the present investigation, although not entirely consistent, reveal roughly the serological ranking of the various species under consideration. Greater reliability probably will proceed from the use of more purified and better standardized reagents than were employed in the tests reported herein. Other experiments are now in progress which make use of more refined procedures.

SUMMARY

1. Methods and data regarding the preparation of *Drosophila* antigens and antisera were offered.

2. The complement fixation reaction was used in comparing the reactivity of several antigens to different antisera, and the results were presented in Table 6.

3. From the data in Table 6, the percentage of antigen-antibody reactivity was calculated. These calculations were based upon the highest antiserum dilution at which complement was fixed, and upon the total number of +'s recorded in the tests. These methods are modifications of the Boyden and of the Nelson and Birkeland computation technics. The new calculated values were recorded in Table 7.

4. The values in Table 7 were indicated as revealing the ranks assumed by the various antigens with reference to a given antiserum.

5. A discussion was given of the reliability of the complement fixation reaction in differentiating *Drosophila* species.

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BOOK REVIEW

A Catalogue of the Original Descriptions of Rhopalocera Found North of the Mexican Border. Edited by F. Martin Brown. *Part I—Hesperioidea,* by E. L. Bell, October 4, 1938. Bulletin of the Cheyenne Mountain Museum, Colorado Springs, Colorado. Vol. 1, No. 1. Price 50 cents.

This, the initial publication of the Cheyenne Mountain Museum, is a happy augury for the future of that institution. Since the Supplement to Skinner's Catalog in 1904 there have been no generally available bibliographic publications on the whole Butterfly fauna of North America, and in view of the enormous increase in the number of names that has occurred since that date, the series of which the present work is the beginning will fill a very great need. All names applied to North American Butterflies are included, with statements of the type localities and references to the original descriptions. References to the original descriptions of the genera are given; and the genotypes are listed. Unfortunately no other generic synonymy has been included.

Synonyms and aberrations are rightly classed together as invalid names; but these should be printed in italics rather than in capitals. Subspecies (race) names have been indented properly under the species names, but it would be better to prefix "(a)," "(b)," etc., to these, as is usually done in such lists. Most annoying to workers is the use of abbreviated and incomplete bibliographic references. In this respect the present work is better than many; but there is room for improvement. To the specialist such references as "Bull. Buff. Soc. Nat. Hist.," "Jahrb. nass Ver.," "Contrib.," "Verh. z.-b. Ges. Wein. (sic)," etc., may be intelligible; but to the majority of users of a work such as this they are a source of worry. I personally believe that all bibliographic references should be given without abbreviation; and that in separate publications the name of the publisher and the place of publication should always be included. It would also be better if the volume numbers were printed in bold-face type.

The above criticisms deal with comparatively minor points, however, and merely represent the eternal tendency of the human mind to strive for an unattainable perfection.

ALEXANDER B. KLOTS

TAXONOMIC NOTES ON THE DIPTEROUS FAMILY CHLOROPIDÆ. I[1]

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During the course of studies on the classification of a group, there is a gradual accumulation of miscellaneous items, new species, synonymy, etc., which cannot properly be included under the specific titles of other papers, or which are brief additions or corrections to them. The following notes on the Dipterous family Chloropidae are presented herewith, since they are not pertinent to generic revisions now in progress.

Oscinella mallochi Sabrosky. New name.

Equals *O. halterata* Malloch 1913 nec Lamb 1912.

Malloch (1913, Ins. Insc. Menstr., I, p. 47) described *Botanobia* (*Oscinis*) *halterata* from Washington, D. C., and it was recorded as such by the writer in his recent synopsis of the Nearctic species of *Oscinella* and *Madiza* (1936, Annals Ent. Soc. Amer., XXIX, p. 724). However, the use of *Oscinis halterata* by Lamb (1912, Linn. Soc. London, Trans. (Zool.), XV, p. 343; Chloropidæ of the Seychelles Islands) preoccupies the name. I therefore propose *mallochi* for the American species, in honor of the describer, J. R. Malloch, who has contributed so much to the study of the Chloropidæ of the world.

Haplegis fossulata (Loew)

Chlorops fossulata Loew. 1863. Berl. Ent. Ztschr., VII, p. 43. (Cent. III, no. 82.)

Chloropisca atra Curran. 1926. Amer. Mus. Novitates, 220, p. 3. New synonym.

In a recent review of the Nearctic species of *Chloropisca* (1936, Canad. Ent., LXVIII, pp. 170–177), the writer recorded specimens of *C. atra* from Texas, personally compared with the types

[1] Journal Article No. 293 (N.S.) from the Michigan Agricultural Experiment Station.

in the American Museum, from Arecibo, Porto Rico. At the time, doubt was expressed of the generic position of the species. Upon seeing one of the specimens, Mr. Malloch very kindly called my attention to the fact that the species is really *Haplegis fossulata* Loew, described from Cuba. The synonymy suggested by Malloch was confirmed from my notes, which I had overlooked, on the type of *fossulata.* The species differs in important respects from the four Palæarctic species of *Haplegis* in my collection, and should probably be assigned to some other genus.

The species appears to be quite widely distributed around the Gulf of Mexico, for in addition to the type localities in Cuba and Porto Rico, and my records from Texas, Mr. Malloch wrote me that he has seen specimens from Mexico and the Panama Canal Zone, and Curran has recorded it from Jamaica. Becker (1912, Chloropidæ V, p. 148) recorded it from Paraguay, but his description differs in a few particulars.

Chloropisca species

Since the publication of my review of Nearctic *Chloropisca* (*op. cit.*), the known distribution of the several species has been notably extended. The following localities are worthy of record in this connection:

C. appropinqua: Alamogordo, N. Mex.; Cheyenne, Oklah., June 7, 1937; numerous scattered localities in Utah.

C. grata: Gull Lake, Alberta; Hendersonville, N. C. The latter is the first specimen from south of Pennsylvania to be seen by the writer, although a record from Florida is in the literature.

C. obtusa: Appanaug, R. I., June 22, 1912 (C. W. Johnson). The species is so seldom found in collections that any record is worthy of note.

C. parviceps: Swarthmore, Pa., July 18, 1909; Falls Church, Va., June 20, July 12, Aug. 9, and Sept. 7 (N. Banks); Norwich, Vt., July 8, 1908 (C. W. Johnson). The species was previously known to me only from Illinois and Indiana, but these eastern records indicate that it has a much wider distribution. It seems rather uncommon.

C. pulla: A number of additional records have confirmed the writer's view that the species has a wide distribution: Antioch, Calif. (far western record); Narrows, Mt. Desert, Maine (north-

eastern record); Chain Bridge and Plummer's Island, Md.; Natchez, Miss.; Riverton, N. J.; Cloudcroft, N. Mex.; Adirondacks, N. Y.; Andrews and Bryson City, N. C.; Dallas, Tex.; Spanish Fork, Ogden, Midvale, and Woodscross, Utah; Falls Church and Rosslyn, Va.

C. pullipes: Pingree Park, Colo.; Wallowa Lake, Ore. (a considerable extension northward of the known range); Blanding, Logan and Monticello, Utah.

C. rubida: Kiger's Island, Ore. (northwestern record); Zion and Logan Canyon and Butlerville, Utah.

Chloropisca annulata (Walker)

Chlorops annulata Walker. 1849. List of the specimens of Dipterous insects in the collection of the British Museum, Part IV, p. 1119. (Martin's Falls, Canada.)

Chloropisca variceps (Loew). 1863. Berl. Ent. Ztschr., VII, p. 46. New synonym.

Chlorops annulata Walker (nec Adams 1904) has long been a species incerta. Osten Sacken's Catalogue (1878) listed it with the note "probably *Chloropisca*-Loew," but Becker (1912) in his monograph of the Nearctic Chloropidæ believed it to be a *Diplotoxa* or *Anthracophaga.*

According to the type (British Museum), it is a *Chloropisca,* as Loew surmised, and it is the northern species which Loew described as *variceps.* Walker's name has the right of priority, although a change is unfortunate because of the long established use of *variceps* following Loew's clear characterization.

Additional records: Chatham and Douglas Lake, Mich.; Highrolls, N. Mex., May 29, 1902; Trenton, Currant Creek, Roosevelt, Logan and Nephi, Utah.

Chloropisca bistriata (Walker)

Chlorops bistriata Walker. 1849. List, etc., Part IV, p. 1120. (Martin's Falls, Canada.)

Chlorops bistriata; Osten Sacken. 1878. Catalogue, p. 209. (Note by Loew: "apparently *Chlorops* in the narrower sense.")

Chloropisca bistriatus; Aldrich. 1905. Catalogue, p. 633. (Synonym of *C. assimilis* Macq.)
Chloropisca glabra var. *clypeata* Malloch. 1914. Canad. Ent., XLVI, p. 119. New synonym.

Examination of the type of *bistriata* in the British Museum has revealed that it is the form known as *clypeata* Malloch. In reviewing Nearctic *Chloropisca* (*op. cit.*), I discussed the status of *clypeata* and concluded by calling it a variety of *C. glabra,* at least pending further data.

An additional character noted by Malloch will be found useful in separating *bistriata* from *glabra:*

Fore metatarsus black, occasionally yellow at the extreme base. *glabra* (Meig.)
Fore metatarsus, and usually part of the second tarsal segment, yellow .... *bistriata* (Walk.)

Additional records: Ft. Kent, Maine; E. Lansing, Mich.; Fayetteville, N. C.; Holderness, N. H.; Delaware Water Gap, N. J.; Falls Church, Va.; Madison and Wazeka, Wis.

Elachiptera (= *Crassiseta* v. Roser) species with reddish body color.

In studying specimens of *Elachiptera* with reddish body color from scattered localities from Florida to Paraguay, it was impossible to determine species from the generalized descriptions. A recent study of the types[2] has made possible a better though still incomplete understanding of their identity. In view of the close similarity among the types and the small amount of material available, however, I hesitate to do more than suggest tentative conclusions on their status. Of the many published records, it is impossible to say which species was before the recorder without a reexamination of the actual specimens.

Elachiptera eunota Loew and *E. melampus* Becker (possibly a melanic form of *eunota*) have the thorax chiefly dark reddish, but the more extensive black areas and the entirely black triangle and antennæ will prevent inclusion of these species.

[2] The examination of types in European museums was made possible by a Grant-in-Aid from the Permanent Science Fund of the American Academy of Arts and Sciences.

KEY TO THE REDDISH SPECIES OF ELACHIPTERA OF THE WESTERN HEMISPHERE

1. Scutellum black, with four long, yellow tubercles; triangle small, not extending beyond the middle of the front .... *punctulata* Becker
   Scutellum yellow to reddish, tubercles small or absent; triangle long, approaching the fore margin of the front 2
2. Mesonotum thinly pollinose, the pollen somewhat denser on the disk, appearing as a broad stripe between the dorsocentral lines. **pollinosa** Sabrosky, n. sp.
   Mesonotum shining, not pollinose, except for a narrow band on the posterior slope immediately before the scutellum 3
3. Antennal arista slender throughout most of its length, broad and flat only at the base if at all, long haired; only the apical scutellar tubercles evident 4
   Arista sword-shaped, equally broad nearly to the apex, with short hairs (cf. note under *attenuata*); South America 5
4. Arista slender throughout, only slightly thickened basally; thorax entirely reddish yellow; hind tibiæ yellow .... *flavida* Will.
   Arista moderately broad and flat basally, strongly attenuated so that the apical third is quite slender; mesonotum conspicuously black marked; hind tibiæ blackish .... *attenuata* (Adams)
5. Both subapical and apical scutellar tubercles distinct .... *rubida* Beck.
   Only the apical tubercles distinct .... *sublineata* (Beck.)

Elachiptera punctulata Becker

Elachiptera nigroscutellata Becker. 1912. Ann. Mus. Nat. Hung., X, p. 80.

Elachiptera punctulata Becker. 1912. *Op. cit.*, X, p. 645. (Nom. nov., = *nigroscutellata*, preoc.)

No published records are known to me, and the type locality was given only as "North America." The type has been examined, in the Winthem Collection in Vienna. It is quite unlike the other species, resembling *E. costata* Lw. because of the large scutellar tubercles, and it is included here only because of the general color of the body.

Elachiptera pollinosa Sabrosky, new species.

Equals *E. flavida* Duda nec Williston (misident.).

Slender species, agreeing with *attenuata* in general habitus and characteristics. It differs from *attenuata* and the other reddish species by the pollinose mesonotum.

Head yellow, the occiput, triangle and antennæ darker and the cheeks whitish, only the arista, narrow tip of third antennal segment, ocellar tubercle and a V-shaped occipital spot black. Front only slightly wider than an eye,

anteriorly truncate, the sides parallel. Triangle smooth and polished, not pollinose, not touching the eyes at vertex and nearly reaching the anterior margin of the front, the sides very slightly convex; a row of distinct but pale and slender hairs arise in fine punctures on the triangle near each side, and arch over the triangle. Occiput convex behind each eye, but somewhat concave mesally. Eyes sparsely pale pubescent, large, suboval, the posterior border nearly straight, long axis slightly oblique. In profile, the front projects only slightly beyond the eyes, but the face is receding because of the short cheeks. Cheeks narrow, only $\frac{1}{4}$ to $\frac{1}{3}$ the height of the third antennal segment and 1/7 the height of an eye. Face concave, the median ridge slightly developed on the upper portion. Oral opening, palpi, and proboscis small. Antennæ comparatively large and prominent, porrect; third antennal segment reniform, much broader than long. Arista somewhat thickened and densely long pubescent, but not broadened and flattened. A row of distinct, pale orbital hairs and numerous pale hairs on the front; inner verticals and erect, cruciate ocellar bristles short and inconspicuous; outer verticals and cruciate erect postverticals conspicuous by their length and darker color; vibrissal hair strong.

Thorax and scutellum deep yellow to reddish, the notum darker, a narrow black area at the neck opposite the occipital spot, and in some specimens a narrow blackish stripe laterad of each dorsocentral line. Thorax subshining, the notum and scutellum thinly but distinctly covered with bright yellowish gray pollen, which is somewhat denser between the dorsocentral lines and appears as a broad median stripe in well preserved specimens. The humeri and pleura, except for a small area on the upper part of the mesopleura, polished and not pollinose. A few pale hairs set in fine punctures on the notum and scutellum, with irregular rows of divergent hairs on the median and dorsocentral lines, and a single irregular row of reclinate hairs on the intervening areas. Bristles prominently developed, blackish: 1 + 1 notopleural, 1 postalar, 1 posterior dorsocentral, and 1 apical scutellar. Scutellum flattened on the disk, apically subtruncate, the apical bristles on black, enlarged bases. Subapical bristles inconspicuous, one pair slightly developed. Metanotum orange.

Abdomen of the type not in good condition; in other specimens yellow with black basal corners and a median dorsal black stripe which occupies about $\frac{1}{3}$ of the dorsal aspect of segments three to five, narrower on the first and second. Lateral margins of the tergites infuscated.

Legs yellow, the fore tarsi and the terminal segment or two of the mid and hind tarsi blackened. Sensory area distinct, on hind tibia.

Wings hyaline, yellow-tinted, veins brown. Second and third costal sectors subequal, varying slightly. Veins three and four divergent from the base. Anterior cross-vein near the middle of the discal cell, and only $\frac{1}{2}$ the length of the hind cross-vein. Ultimate sector of fifth vein slightly longer than the penultimate sector of fourth vein.

Length, 1.75–2 mm.

Holotype, ♂, Villarica, Paraguay, August, 1937 (F. Schade). Allotype, Villarica, May, 1937 (Schade). Paratypes: ♀, same data as allotype; ♂, Gualan, Guatemala, Jan. 20, 1905 (J. S. Hine). Type, allotype and parallotype in the author's collection, male paratype in Hine Collection, Ohio State University.

The specimen from Guatemala may be questioned because of the distance from the type locality, but I am unable to separate it from the Paraguayan examples.

One male, Petropolis, Rio de Janeiro, Brazil, May, 1934 (R. Uete) may possibly belong here, with characteristically pollinose mesonotum, but the arista is broad and flat, presenting a much different appearance.

Duda (1930, Folia Zool. Hydrobiol., II, p. 81) described *flavida* Williston as having thickly pollinose mesonotum, but the type of *flavida* (British Museum) has the disk polished and without pollen. The type of *ruficollis* Frey has not been studied, but it was described as possessing a shining thorax and probably equals *sublineata* (Becker).

Elachiptera flavida Williston

Elachiptera flavida Williston. 1896. Ent. Soc. London Trans., 1896, p. 417. (St. Vincent.)

Oscinis mitis Williston. 1896. *Op. cit.*, p. 424. (St. Vincent.) New synonym.

Close to *attenuata* in general appearance, having the polished mesonotum without pollen on the disk. The arista is only slightly thickened and flattened toward the base, however, and is quite slender throughout most of its length. The mesonotum and pleura are entirely reddish yellow, with no sign of black striping, and the back of the head is only slightly infuscated centrally. The mesonotum has numerous pale hairs set in fine punctures, with two rows of punctures between the median and each dorsocentral row. Legs yellow. In general color, proportions and bristles, it agrees quite well with the description of *E. pollinosa*.

There is considerable doubt of the extent to which this name may be applied. Although there are published records of its occurrence from Chile and Peru to Porto Rico, Cuba, and Florida, I have seen no specimens from these and other regions which entirely agree with the series of four cotypes in the British

Museum, from the Island of St. Vincent. It is possible that *flavida* and *attenuata* are really the same species, widely distributed and variable in the extent of color and the development of the arista, in which case the former name has priority. However, fully matured topotypic specimens of *attenuata* are so distinct in the pattern on the occiput, mesonotum, and hind tibiæ that I believe the concept requires recognition.

The four cotypes of *O. mitis* were compared directly with those of *flavida.* Although the aristæ are missing on all specimens of *mitis,* the similarity otherwise is so great that there seems to be no question of the synonymy.

Elachiptera attenuata (Adams)

Crassiseta attenuata Adams. 1908. Jour. N. Y. Ent. Soc., XVI, p. 152. (San Jose de Costa Rica.)

Elachiptera pilosa Duda. 1930. Folia Zool. Hydrobiol., II, p. 81. (San Jose, Costa Rica.) New synonym.

Similar to *E. pollinosa,* but not pollinose. Fully matured specimens are conspicuously marked with black fore tarsi, distal segment or two of mid and hind tarsi, distal portion of fore tibiæ, and the hind tibiæ blackish, a black line in each dorsocentral position and one on the lower rim of the notopleura. The occiput is broadly blackened on its central area, and usually the area between the black central area and each eye is also infuscated so as to appear as a broad black band reaching from eye to eye. The arista is somewhat broadened and flattened at the base, but strongly attenuated so that the distal third is slender. The abdomen is generally black to black-brown, only the membranous venter and ofttimes a median dorsal spot at the base, orange.

The type of *attenuata* has not been located, although I have examined the collections of Adams, the Hough Collection, and the Snow Collection at the University of Kansas, in which the types of Adams' species were usually deposited. However, the description mentions the distinct features of the arista "rapidly attenuated on outer third," the two sublateral black lines on the mesonotum, and the infuscated tarsi and hind tibiæ. These features are also characteristic of the long type series (5 ♂, 3 ♀) of *E. pilosa* Duda (same type locality as *attenuata*) and of other Costa Rican and Central American material which I have seen.

The relative status of *flavida* and *attenuata* is discussed under the former heading.

Distribution: *Costa Rica:* Farm La Caja near San Jose (H. Schmidt), type series of *E. pilosa* (Zool. Mus., Hamburg); 2 ♀, same locality and collector, and 3 ♂, 3 ♀, labeled only "Costa Rica, Knudsen 1920" (Naturhist. Mus., Vienna). *Cuba:* Soledad, Feb. 14, 25, and Mar. 2, 1925 (Mus. Comp. Zool., Harvard Univ.); Paso Real, April 23, 1923, and Marianao, April 15, 1923 (Hine Colln., Ohio State Univ.). *Guatemala:* Los Amates, Jan. 16–20, 1905 (Hine Colln.).

Specimens from Brownsville, Texas, June 11–16, 1933 (Mus. Comp. Zool.), Everglades, Florida, Aug. 11, 1930 (Snow Colln., Kansas Univ.), and Lakeland, Florida, May 6, 1916 (Cornell Univ. Colln.) are recorded here with some doubt. The arista is broadened and flattened nearly to the tip, the occiput is infuscated only centrally, and the mesonotal striping is not distinct; otherwise the specimens agree with *attenuata.*

Published records: specimens have been recorded as *attenuata* from Ormond, Florida (Johnson, 1913, Amer. Mus. Nat. Hist., Bul., XXXII, p. 87), and from Jamaica (Gowdey, 1927, Dept. Agr. Jamaica, Ent. Bul., IV), and as *flavida* from Cuba, Porto Rico, and several localities in Florida. It is probable that some at least of these records may properly be referred to *attenuata,* but the exact status could be determined only by checking the original specimens.

Elachiptera rubida Becker

Elachiptera rubida Becker. 1912. *Op. cit.,* X, p. 179.

The broad arista and the presence of distinct subapical scutellar tubercles seem to be the only tangible characters for separating the species from *attenuata,* although a long series might reveal consistent differences in size and proportions. The female holotype (Tacna, Peru, Nov. 27, 1902; Schnuse Colln., Dresden) has a longer and broader arista than in West Indian and Central American material, and the mesonotum seems to be broader in proportion to its length, presenting a stouter appearance.

Elachiptera sublineata (Becker)

Melanochæta sublineata Becker. 1912. *Op. cit.,* X, p. 181. (Paraguay.)

Melanochæta ruficollis Frey. 1918. Ofvers. F. Vet.-Soc. Förh., LX (A), p. 23. (Rio de Janeiro, Brazil.) New synonym (?).

It seems quite probable that this is really a synonym of slender-bodied *E. attenuata,* which it resembles greatly. The type of *sublineata* (Hung. Nat. Mus., Budapest) has the arista slightly but equally broadened nearly to the tip, although by no means as broad as in *E. rubida,* and the back of the head has only the central infuscation; otherwise it agrees with *attenuata.* The type of *ruficollis* Frey has not been examined, and I hesitate to place it in synonymy merely from the general description. It was separated from *sublineata,* however, only by the dubious character of the relative extent of black on the fore-legs, abdomen and thorax, and will probably prove to be the same species. The published records of *sublineata* from Argentina (Malloch, 1934, Dipt. Patagonia & S. Chile, Brit. Mus., VI, p. 419) and Paraguay (Duda, 1930, Konowia, VIII, p. 166) are probably correct.

Ceratobarys eulophus (Loew)

Inasmuch as this species is almost identical in appearance with *Crassiseta flavida,* differing notably by the possession of a distinct hind tibial spur and darker legs, it is appropriate to record the distribution for comparison with that of *flavida.*

The available records are confined to southern United States, ranging from Texas to Florida and up into North Carolina. The type is from Texas, and Malloch's revision of *Hippelates* (1913, U. S. Nat. Mus. Proc., XLVI, p. 263) recorded it from Plano and College Station, Texas, as well as from Georgia. Becker (1912) added a record from Opelousas, La. In addition to these published localities, I have seen specimens from the following:

Florida: Hilliard, Aug. 19, 1930 (R. H. Beamer; on *Hypericum densiflorum*) (Snow Colln., Kansas Univ.); *Georgia:* Prattsburg, July 25, 1930 (Kansas Univ.), and Billy's Island, Okefenokee Swamp, June, 1912 (Cornell Univ.); *Louisiana:* New Orleans, Feb. 23, 1923 (Mus. of Zool., Univ. of Mich.), New Orleans, May 28, 1905 (Hine Colln., Ohio State Univ.), and Opelousas, Mar., 1897 (Hough Colln., Field Mus.); *North Carolina:* Raleigh, late July (N. C. Dept. Agr. Colln.); *South Carolina:* Manning, May 29–30, 1914 (Acad. Nat. Sci. Phila.).

Tricimba Lioy (*Notonaulax* Becker)

The recent discovery of the type of *Tricimba trisulcata* Adams in the Hough Collection (at present at the Field Museum in Chicago) prompted an examination of Nearctic species in the genus, with a determination of the status of this long-lost type.

As Malloch has already noted, the generic synonymy under *Tricimba* is still in confusion, and no attempt will be made to list it here. I may point out, however, that *Hammaspis,* erected by Duda for the single species *spinigera* Malloch, and accepted by Malloch as a subgenus of *Tricimba,* is really an absolute synonym of *Tricimba* Lioy *sensu strictu.* Malloch placed *spinigera* as a synonym of *lineella* Fallén, and while I believe that the two are distinct (*cf.* discussion under *spinigera*), they are closely related and are certainly congeneric. Since *lineella* was long ago (Enderlein, 1911) selected as the genotype of *Tricimba,* the genus *Hammaspis* is an absolute synonym by virtue of a congeneric genotype.

Duda has proposed several generic names for species which were included in *Tricimba sensu latu,* but I shall not attempt to pass upon their scope or validity at this time. His genera *Aphanotrigonum* (for *Tricimba trilineata* Meigen) and *Conioscinella* (including faintly furrowed species) may well include some of our American species, of which there are several having only slightly deepened lines of punctures on the mesonotum. The species which I have considered here under *Tricimba* have three deeply incised furrows on the mesonotum.

Becker (1912), in his monograph of the Nearctic Chloropidæ, found two species of *Tricimba* in North American material, the European *cincta* Meigen and a new species from Washington State, *brunnicollis.* He saw no specimens of *Oscinis trisulcata* Adams, and included it in his key to *Oscinella* as a striped species. In Nearctic material submitted to me for determination, five species are recognized tentatively, pending an opportunity and sufficient material to investigate their specific and varietal relationships. The European and Nearctic species are so similar that one must compare them carefully in analyzing our fauna. Wherever possible, determined Palæarctic material was studied; in other cases, the characteristics were drawn from detailed descriptions by European students of the family.

KEY TO THE NEARCTIC SPECIES OF TRICIMBA

1. Notopleural bristles 1 + 1; four yellow, spine-like marginal scutellar bristles, subequal in length and equidistant from each other, each situated on a small black tubercle slightly ventrad of the margin of the scutellum; one row of hairs between the median and each dorsocentral row .... *spinigera* Malloch[2]

   Notopleural bristles 1 + 2; scutellar bristles not as above, the apical scutellars approximated and distinctly longer than the subapicals; several rows of hairs between the median and each dorsocentral row 2

2. Humeri, propleura and scutellum with entirely black ground color; scutellum somewhat conical, with distinct apical scutellars and 2–3 pairs of short, indistinct subapicals; all femora and the hind tibiæ more or less infuscated in the males, somewhat paler in the females. *brunnicollis* Becker

   Humeri and propleura black, the scutellum with orange apex; scutellum somewhat conical, with well-developed apical and one pair of scarcely distinct subapical bristles; legs yellow .... *cincta* Meigen

   Humeri and propleura partly or entirely yellow to orange, at most reddish brown; scutellum with yellow apex 3

3. Humeri and propleura yellow; scutellum conical, broadly yellow at the apex, with well-developed apical but indistinct subapical bristles; legs yellow .... *occidentalis* Sabrosky, new species

   Humeri black above, the lower half and the propleura generally orange, occasionally reddish brown; scutellum broader and rounded apically, with long apical and two to three pairs of long, well-developed subapical bristles; legs yellow, hind femora with a median black band, middle femora with a black spot on the postero-ventral surface. *trisulcata* Adams

Tricimba spinigera Malloch

Tricimba spinigera Malloch. 1913. Ins. Insc. Menstr., I, p. 60. (D. C., Md.)

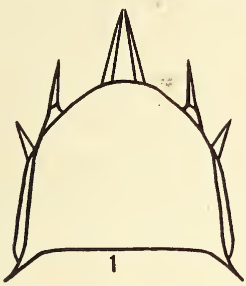
Hammaspis spinigera; Duda. 1930. Folio Zool. Hydrobiol., II, p. 76. Holotype of *Hammaspis*.

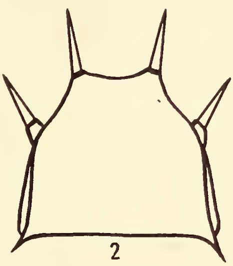
Tricimba (*Hammaspis*) *lineella;* Malloch. 1934. Dipt. Patagonia & S. Chile, Brit. Mus., VI, fasc. 5, p. 425, 426. *Hammaspis* accepted as subgenus; *spinigera* a synonym of *lineella* Fallén.

[2] Since this paper was written the writer has seen two specimens, from Isle Royale, Mich., Aug. 3–7, 1936 (C. W. Sabrosky), and Atherton, Mo., May 7, 1916 (C. F. Adams), which have the scutellum as in Fig. 1, though with the first pair of subapical bristles slightly divergent. These may be recorded as typical *lineella* Fallén, may be distinguished from *spinigera* Malloch by the above figures.

After a detailed study of European material, I believe that Malloch's name should be retained for the American species, based upon differences in the scutellum and its bristles. In other particulars the species are almost identical, and are congeneric.

In both species, the marginal scutellar bristles are short, stout, and yellow or whitish-yellow. In *lineella* (*cf.* Fig. 1), the bases





of the apical scutellars are closely approximated, and the bristles are strongly convergent; there are two pairs of subapical scutellar bristles, of which the posterior pair is parallel and directed posteriorly, and the anterior pair is slightly divergent; the subapicals are even shorter than the short apical bristles. A more striking appearance is presented by the scutellum of *spinigera* (Fig. 2), which bears only one pair each of apical and subapical marginal bristles, subequal in length, equally spaced on the margin, and so directed as to give a radiate appearance to the scutellum. A marked difference will also be noted in the shape of the scutellum, and in its length in proportion to the length of the bristles.

Distribution of *spinigera:* eastern United States, from Maine to Georgia, and west to Kansas and Texas. In addition to the type series, I have seen specimens from the following unrecorded localities:

Georgia: Black Rock Mountain, Rabun County, May 20–25, 1911 (Acad. Nat. Sci. Phila.); *Illinois:* Urbana (U. S. Nat. Mus.); *Indiana:* Lafayette (U. S. Nat. Mus.); *Iowa:* Mt. Pleasant, Feb. 19, 1932 (Iowa Wesleyan Colln.); *Kansas:* Manhattan, Sept. 27, 1933 (on flowers of aster) and Oct. 1, 1933 (Author's Colln.); *Maine:* S. W. Harbor, Sept. 6, 1922 (Boston Soc. Nat.

Hist.); *Maryland:* Plummer's Island, April 8, 1914 (U. S. Nat. Mus.); *Michigan:* Battle Creek (U. S. Nat. Mus.); *Missouri:* Atherton, April 30, 1902 (Ark. Univ. Colln.); *Texas:* Cameron County, Aug. 3, 1928 (Snow Colln., Kansas Univ.); *Virginia:* Falls Church, June 10, Oct. 7 (Mus. Comp. Zool., Harvard Univ.).

Tricimba brunnicollis (Becker)

Notonaulax brunnicollis Becker. 1912. Ann. Mus. Nat. Hung., X, p. 103.

This is the darkest species of the four closely related forms aside from *spinigera.* It would seem to be close to the European *cincta* var. *apicalis* von Röser, with dark scutellum and the femora more or less infuscated. I have seen no specimens of the latter, however, and since Becker recognized *brunnicollis* as a good species, it should be recorded as such, at least for the present.

In the males which I have seen, all femora, and the hind tibiæ centrally, are infuscated, whereas in the females (including the types) the legs are somewhat paler and the femora are only slightly infuscated. In good specimens, many of the hairs on the front are set in brown spots slightly darker than the surrounding color.

Distribution: far western, according to present records. *California:* 2 ♂, 5 ♀, Del Norte County, May, 1910 (Deutsches Ent. Mus.); *Oregon:* Josephine County, 1910 (Deut. Ent. Mus.); *Washington:* Copalis, July 25, 1931 (Snow Colln., Kansas Univ.), Friday Harbor, July 2, 1905 (type series, U. S. Nat. Mus.), also a paratype, same locality, July 19, 1905, in Melander's Collection.

The specimens recorded as *brunnicollis* from Kansas by Sabrosky (1935, Amer. Ent. Soc. Trans., LXI, p. 256) do not represent the species, as I recognized when I had an opportunity to study Becker's type.

Tricimba cincta (Meigen)

Becker, in monographing the Nearctic Chloropidæ, recorded specimens from many widely separated localities under the name of Meigen's European species, and the practice has been con-

tinued by later authors (*e.g.*, Aldrich, 1913, Mono Lake, Calif.; Gibson, 1917, Ottawa, Ontario and Aweme, Manitoba; Johnson, 1925, New England List; Leonard, 1926, New York List).

The study of a long series of determined European specimens from four different sources, including Dr. O. Duda who recently monographed the Chloropidæ for Lindner's extensive work on Palæarctic Diptera, has failed to assure me that the name can be applied so generally in this country. It is possible that the concepts which I have recognized under *occidentalis* and *trisulcata* may ultimately be found to be races or varieties of *cincta,* but until more definite information is available it seems advisable to give them separate recognition. The distinctive characters are stated in the key, those of *cincta* being taken from determined European material and checked with Duda's detailed redescription.

Specimens from eastern United States differ from typical *cincta* in the shape and proportion of the scutellum, the development of scutellar bristles, and somewhat in color. Fortunately, no new name is required for the concept, since I find from the type that *Oscinis trisulcata* Adams is this eastern species. Likewise, some western specimens differ so conspicuously in the color of the humeri and propleura that it is necessary to separate them from typical *cincta* (*cf. occidentalis*). A few western specimens agree well with European material of *cincta,* and are therefore recorded as such.

Distribution of *cincta:* western. *British Columbia:* Goldstream to Downie Creek, Selkirk Mts., Aug. 7–11, 1905 (Cornell Univ. Colln.); *California:* Berkeley Hills, Alameda County, April 20, 1908 (Acad. Nat. Sci. Phila.).

The status of published records of *cincta* is uncertain. I have checked the specimens upon which Johnson based his New England records, and they can be referred to *trisulcata* Adams. It is probable that all of the eastern records refer to Adams' species, but the proper placing of the western records is unknown to me at present.

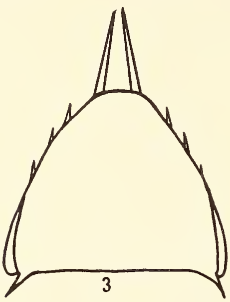
Tricimba occidentalis Sabrosky, new species.

Close to *Tricimba cincta* Meigen, but characterized by conspicuously yellow humeri and propleura, and pale brown to yellow thoracic bristles.

♀. Head yellow, the back of the head and the vertical triangle black, gray

dusted; clypeus black; all bristles of the head pale yellow, short and inconspicuous; eyes with minute pale pubescence; front wider than an eye, brown on the posterior third, thickly beset with short, pale yellow hairs; antennæ brown at the base of the arista; face slightly concave in profile; height of the cheeks slightly less than the breadth of the third antennal segment and about one-fourth the height of the eyes.

Mesonotum black, densely gray dusted, with numerous short, pale hairs and pale bristles; notopleurals 1 + 2, 1 postalar, 1 posterior dorsocentral; the three impressed lines of punctures as in *cincta;* humeri, propleura, and the apex of the scutellum broadly, deep yellow, the posterior portion of the notopleura also yellowish; remainder of the pleura black, polished below, the mesopleura and pteropleura gray pollinose; metanotum shining black; scutellum (Fig. 3) rather conical, long and narrow, the length subequal to



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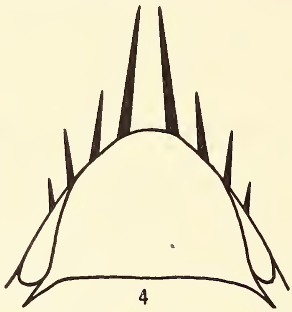

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the basal breadth, with a pair of distinct, well-developed apical scutellar bristles and several pairs of subapicals which are scarcely distinguishable from the discal hairs.

Abdomen dark brown above, the membranous venter and the two basal segments orange except for a spot in each anterior corner of the second segment.

Wings as in *cincta*, the second costal sector approximately twice as long as the third sector, third and fourth veins subparallel, slightly diverging near the apex of the wing, the outer cross-vein oblique. Halteres yellow.

Legs, including all coxæ, entirely pale yellow; sensory area on hind tibiæ elongate.

Length, 1.5–2 mm.

Holotype, ♀, Giant Forest, California, July 28, 1929 (R. H. Beamer). In the Snow Collection, University of Kansas. Paratypes, ♀, two, Orange County, Calif., July 14, 1929 (P. W. Oman); one, Palo Alto, Calif., Oct. 20, 1894 (R. W. Doane); one, Hood River, Oregon, July, 1931 (R. H. Beamer). In the University of Kansas and the Author's Collection.

I have seen no specimens of the European *humeralis* Loew, but from the description it would seem to be similar in general appearance to both *occidentalis* and *trisulcata,* having the humeri, part of the notopleura, and the apex of the scutellum yellow. *Humeralis* differs from both species, however, in that the cheeks are as broad or broader than the third antennal segment, and the triangle has a glabrous, shining black spot on the triangle anterior to the median ocellus. The relationship to *cincta* var. *flavipila* Duda is not clear, but if *flavipila* differs from *cincta* only by the pale bristles, as described, then *occidentalis* is still distinct because of the yellow humeri and propleura.

Tricimba trisulcata (Adams)

Oscinis trisulcata Adams. 1905. Ent. News, XVI, p. 111.

Oscinella trisulcata; Becker. 1912. Ann. Mus. Nat. Hung., X, p. 118.

Tricimba trisulcata; Malloch. 1913. Canad. Ent., XLV, p. 178.

Notonaulax cincta; Johnson. 1925. List of the Diptera of New England.

The holotype of *trisulcata,* which I have before me, was found in material received for study from the Hough Collection, at present in the Field Museum in Chicago. It is a *Tricimba,* close to *cincta* Meigen. As noted under *cincta,* and in the key, there are some differences which appear to warrant specific recognition. Adams' name is available and should therefore be used until the question can be settled satisfactorily. The paler humeri and propleura, the broadly rounded scutellum (Fig. 4), the longer apical and the two to three pairs of long subapical scutellar bristles, and the distinct pattern on the legs (at least in matured specimens), distinguish the species from European material of *cincta* which I have examined.

The type is obviously somewhat teneral, and it is therefore difficult to detail the characteristics from this specimen alone. The characters used in the key are evident, however, and there is no difficulty in associating eastern material with it. The abdomen is broken making it impossible to determine the sex.

Distribution: eastern. *Kansas:* Abilene, Aug. 30, 1932

(Author's Colln.); *Louisiana:* Opelousas, March, 1897 (type, Hough Colln.); *Maryland:* long series, Plummer's Island, May 14, 26, June 8, Aug. 25, 1914, all but one labeled "At light" (U. S. Nat. Mus.); *Massachusetts:* Holliston, Sept. 8 (Mus. Comp. Zool.), Brookline, Sept. 24, Dedham, Sept. 4, and Auburndale, June 28, the latter two recorded by Johnson (1925) as *Notonaulax cincta* (Boston Soc. Nat. Hist.); *New Hampshire:* Mt. Monadnock, June 22, 1917, recorded by Johnson as *N. cincta* (Boston Soc. Nat. Hist.); *South Dakota:* Elk Point, June 19, 1924 (S. Dak. State Coll.); *Virginia:* Falls Church, May 14 and Aug. 28 (N. Banks Colln., Mus. Comp. Zool.), Rosslyn, July 11, 1913 (U. S. Nat. Mus.). A lone specimen from Batesburg, S. C., Aug. 24, 1930 (R. H. Beamer) (Snow Colln., Kansas Univ.) differs slightly, and is recorded here with some doubt.

Tricimba seychellensis Sabrosky. New name.

Equals *Tricimba trisulcata* Lamb (*Notonaulax*), preoccupied.
Notonaulax trisulcata Lamb. 1912. Linn. Soc. Zool., Trans., XV, p. 338.

I find that the use of *trisulcata* Adams (1905) in *Tricimba* preoccupies Lamb's use of the name for a species from the Seychelles Islands in the Indian Ocean. I therefore propose *seychellensis* to replace the homonym.

THE "METAMORPHOTYPE METHOD" IN TRICHOPTERA

By Margery J. Milne
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The case-building habit in Trichoptera makes possible a certainty in associating larvæ and adults not found in life history studies of other aquatic orders. Every caddis worm builds a case before pupation, and walls itself up within the enclosure. The shed larval skin slowly disintegrates until, at emergence time, only the sclerites remain, balled up at the posterior end of the chamber. In a pupa about to transform (easily known by its dark eyes and dark wing pads), the palpi, ocelli and spurs of the adult are readily studied, and more important, the imaginal genitalia are relatively firm and may be carefully dissected out for comparison with identified pinned adults. The pupal skin itself bears an armature of specific form, and by it, younger pupæ may easily be associated. The larval sclerites remaining in the case are not impossible to separate and manipulate with forceps into an understandable orientation. On these sclerites are the most reliable characters for identification of larvæ.

Thus a single pupa just prior to emergence, together with the larval sclerites in its case, offers the student the following: (1) The adult genitalia, spurs, palpi and ocelli, by means of which the species may readily be identified with known adults. (2) The pupal armature, by means of which other pupæ may be associated. (3) The larval sclerites, the hard parts of the preceding instar, through study of which larvæ may be linked with much certainty to the adult on which the specific name is based.

These advantages have not been emphasized in life history studies on Trichoptera, and there is much doubt if the authors of the numerous papers have used what I would like to call the "metamorphotype method." A metamorphotype is a new unit, here proposed, a comprehensive term for the specimen and its parts which serve as proof of an association of stages in the life cycle separated by a metamorphosis. Thus the pupal skin with

its enclosed, not-emerged adult bearing genitalia, and the larval sclerites, all found in a single closed case of a trichopteran, would constitute a metamorphotype. Too much stress can scarcely be laid on the fact that this *single* specimen is entirely adequate to link larval, pupal and adult stages of the species concerned, and that there is no source of error in such an association, since all are parts of one individual. This method is so much superior to that of rearing larvæ to adults that the latter is not worth while in Trichoptera. The advantages might be listed: (1) No possible source of error in association of the several stages. (2) Possible permanence of each metamorphotype, in that it can be deposited in a well recognized museum where future workers are at liberty to consult and check the determination of the species of adult parts, and the characters on which other pupæ and larvæ are linked to it by identification. (3) No complicated field work involving cages in running water, or special laboratory facilities are needed. The collector simply preserves quantities of material while in the field, works it over at his leisure, and keeps separate the cases containing nearly mature pupæ, placing each in an individual vial. Thus weather and disturbing animals and disease have no opportunity to upset careful planning, a feature which will appeal strongly to those who have spent weeks rearing out a few species. A flying visit to a locality suffices to get many associations, and visits repeated weekly during a summer may yield almost every species in a region.

It must be emphasized that emergence of a pupa is a scientific calamity if associations, not perfect specimens, is the goal in mind. Only if the rearing be based upon a single specimen can the association be stated to be indisputable, and there must be proof that all materials relating to an association belong to the same specimen. The metamorphotype method seems to be the only answer to these demands. Where a metamorphotype is mentioned or described in publication, it is only fair to later workers to give it a serial number, mention the name of the authority identifying the species, and deposit the specimen, fully labelled, in an interested (preferably a national) museum, stating in the description the location of the material.

The point of view herein expressed is definitely that of the

laboratory and museum rather than that of the field, and in this way may not be as palatable at first glance to ecologists and economic entomologists as would a treatment of the subject less influenced by considerations of possible synonomy and misidentification. However, it is the large number of errors in applying names to larvæ which has made work published to date of little *proven* worth and which necessitates re-association of most of the species so far claimed as correlated for these instars. In none of the published life histories is there any way of establishing beyond cavil that the larvæ, pupæ and adults belong even to the same genus. In most cases, the gap between larva and pupa, or between pupa and adult, is based upon an assumed solitary rearing, but the conditions indicating the validity of the assumption and the specimens upon which the decisions were made, have not been made available for later verification. The method herein proposed would obviate these difficulties.

OCCURRENCE OF A EUROPEAN SAWFLY ACANTHOLYDA ERYTHROCEPHALA (L.) IN NEW YORK STATE

BY WOODROW W. MIDDLEKAUFF
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On April 22, 1938, I received from Dr. Albert Hartzell of the Boyce-Thompson Institute several adult sawflies for identification. These insects had been collected several days previously by Mr. C. E. Porter at Scarsdale, New York, who reported a large number of the adults flying about close to some Austrian pines. After receiving the information that it is a pest of conifers in Europe Dr. Hartzell and Mr. Porter returned to the same spot on April 28, but were unable to find any additional specimens.

A search through the literature reveals that this insect was first taken in the United States on May 7, 1925, by F. F. Smith and A. B. Wells who took two specimens, both males, from a nursery at Chestnut Hill, Philadelphia, Penna.[1] They reported beating the adults from pine and *Cornus* sp. The next record of this insect was that made by Mr. F. A. Soraci[2] who reported that Mr. C. E. Cobb in mid-June, 1937, noted defoliation of several acres of 5–12 foot red and Austrian pines (*Pinus resinosa* and *Pinus nigra*) in a nursery at Franklin Lakes (Oakland), New Jersey. The larvæ were identified as *Itycorsia zappei* Rohw., but later, after emergence of the adults they were identified as *Acantholyda erythrocephala* (L.). The Division of Forest Insects Laboratory at Morristown, New Jersey, also reported the larvæ as feeding on a 40 foot white pine (*Pinus strobus*) at Convent Station (Morristown) New Jersey. Mr. Soraci states, "since that time, however, the insect has been taken as far south in New Jersey as New Brunswick and as far north as the northern-most corner of the State. Larvæ have also been taken as far east as Alpine in New Jersey."

In so far as I can determine this is the first record of *Acantholyda erythrocephala* (L.) being taken in New York State. The indications are that it is spreading from Philadelphia northward, although this may not be the case. Mr. R. B. Benson of the British Museum kindly confirmed my identification.

1 Wells, A. B. 1926. Notes on Tree and Shrub Insects in S. E. Pa. Ent. News 37: (no. 8) 254–258.

2 Soraci, F. A. 1938. Occurrence of a Sawfly (Acantholyda erythrocephala (L.) in New Jersey. Jour. N. Y. Ent. Soc., Vol. XLVI: (no. 3) 326.

REVIEW OF McDUNNOUGH'S NEW CHECK LIST OF THE MACROLEPIDOPTERA

Check List of the Lepidoptera of Canada and the United States of America. Part I. Macrolepidoptera. By J. McDunnough. Chief, Systematic Entomology, Division of Entomology, Department of Agriculture, Ottawa, Ontario, Canada. 1938. 6.85 × 10.25 in. Memoirs of the Southern California Academy of Sciences, vol. 1, 275 p. Bound in paper. $4.00.

This volume has been expectantly awaited by North American lepidopterists for several years. It brings up to date the first half of the now almost unobtainable Barnes and McDunnough list of 1917, with the additions and nomenclatorial changes that such involves. And, although from one viewpoint Dr. McDunnough is right in referring to the list as a ''thankless job,'' it is a necessary one and one from which all American lepidopterists will obtain much information and help. It covers the butterflies, sphinxes, saturniids, etc., noctuoids, geometroids and ends with the Uranioidea (Epiplemidæ and Lacosomidæ). There is left then for the promised volume II the pyraloids, the true ''micro'' families including the Cossidæ and the primitive Hepialidæ, etc.

This list follows the gross sequence and is written in the same style as the 1917 list. Widely different arrangements of genera and species are found principally in the Noctuoidea (Phalænoidea) and Geometridæ (moths), as one might expect from the interests of the author. Much as individual lepidopterists might prefer this or that change, the fact remains that the list is an advance beyond the mere addition of names and nomenclatorial changes that have appeared in the last twenty years. Some of the shiftings are new, others foreshadowed by the author's recent published works. Lepidopterists are deeply indebted to the author for what he has done here to facilitate and advance the work.

By and large, he has been conservative about making changes, and a number of the features the reviewer would prefer different

are really hang-overs from the style of old lists. For instance, the sequence of families and superfamilies: it is questionable where to place the Sphingidæ but it would seem better to pass from the butterflies to the most nearly related group of moths, namely the Cossidæ—a family which in this arrangement is not even to be found in volume I. Some of these examples of sequence really represent limitations imposed by a linear arrangement but some certainly do not. For instance, why separate the more related Saturnoidea, Bombycoidea and Uranioidea by interspersing them with the Noctuoidea and Geometroidea?

Another relic the reviewer deplores is the paucity of generic synonymy. Even admitting that the citation of generic synonymy in a list might in some instances become complex, still it does not seem consistent to give full specific synonymy and omit the equally desirable generic synonymy.

More or less along this line is the habit, also a repeat from the 1917 list, of ignoring tribal and subgeneric groupings and names. In a sense this is partly the outcome of the compiler's use of many small genera. It probably always will be considerably a matter of individual opinion as to just what constitutes a genus in distinction to a subgenus and tribe or supergenus. Strict uniformity may be unobtainable, even with a group of specialists collaborating, but the reviewer does feel that regardless of whether the genera be made large or small these other group names, tribe (supergenus) or subgenus as the case may be, should be included in some appropriate manner. Certainly if they are to be accepted it would seem that they should be given with the proper species in any list. Grote had an acceptable system for giving what he considered subgenera (see his treatment of the genus *Agrotis* in the 1875 list of Noctuidæ).

Considerable dissention seems likely to arise over McDunnough's refusal to follow the rules of synonymy and homonymy strictly in some cases. The reviewer sympathizes with his view and dislikes seeing well-known names shifted about or sunk as homonyms. In a sense this shifting and changing of names is part of the business of the taxonomist and he can adjust himself without too much travail. But more than the taxonomist is involved. The biological and economic literature is affected and

at times becomes a terrible muddle, and the biological and economic worker who is in no sense responsible for the radical changes in his bibliographies is frequently confused and justly annoyed with nomenclature and thereby with taxonomists. The prime example at the moment is Huebner's ''Erste Zutraege,'' acceptance of which would only shift established names about and advance science not at all, but which would cause great confusion in the taxonomic and non-taxonomic literature of this economically very important group (especially with the old names of ''Noctuid'' genera and even subfamilies). But even so ''the laws'' provide means that should be taken to ignore such disrupting papers, and the reviewer joins the author in hoping that the International Committee will invalidate Huebner's ''Erste Zutraege'' of 1808.

The reviewer would like to have seen a final list of names that have been dropped as not of this fauna (such as was in the 1917 list but is not in this list). The reviewer would also like to see included some symbol to designate ''lost names,'' similar to the way doubtfully occurring species are indicated by an asterisk (Examples: *Agassizia urbicola* Behr, *Homophoberia cristata* Morrison, etc.).

In the Phalaenidæ (Noctuidæ) radical changes have resulted from the abandonment of the Hampsonian artificial classification. The result is an improved although by no means final sequence which in many general respects reminds one of the old Grote lists (1875, etc.) and hence the Smith and Dyar lists. Hampson's large series of volumes, the first world-wide revision, was more usable because it followed a rigid albeit artificial scheme, but it has to be replaced by more natural groupings even though the new groupings cannot be so readily separated by a ''key.''

The author and reviewer are both firm believers in habitus, and this belief is being upheld by recent structural work that is largely post-Hampson. One is wisely wary of the too rigid adherence to the structure of genitalia, but at least in this family the genitalia, female as well as male, are corroborating or being corroborated by other characters to a large degree. Also, recent work on the complexity of wing-pattern determination (Kühn, Henke, Feldotto, etc.) and its comparative morphology (Schwan-

witsch, Süffert, etc.) has given a concrete basis for appreciation of wing-pattern and thereby of habitus.

The changes in this family affect the subfamilies as well as the genera. Aside from the necessary changing of the names of the Agrotinæ to Phalaeninæ, Poliinæ to Hadeninæ and Erastriinæ to Acontiinæ, there is considerable alteration in the sequence of the subfamilies from the 1917 list sequence (more similar to old Grote, Smith and Dyar lists). First are the Pantheinæ followed by the *Acronicta* group which is split off as a separate subfamily. Then come the Phalæninæ, then Hadeninæ, then Cucculiinæ, and then the Amphipyrinæ, a name used for the remainder of the former Acronictinæ after the removal of *Acronicta* and its few close relatives. This subdivision of the old Acronictinæ is highly desirable but still further subdivision of the Amphipyrinæ seems inevitable. Then the Heliothinæ are segregated as a distinct subfamily and given a better position adjacent to *Heliothodes, Palada, Axenus,* etc., of the Amphipyrinæ. Then the Catocalinæ and Erebinæ of Hampson have been intermingled in one subfamily, the Catocalinæ, as Miss Prout, the reviewer and some others have been claiming for years that they should. The Hypeninæ of the 1917 list is split into three subfamilies. Of these the Herminiinæ (Herminiini plus Heliini of Smith) is abundantly distinct as has been pointed out by Forbes; the Rivulinæ while not entirely satisfactory yet seems a good split at least tentatively; the Hypeninæ as here restricted more or less merge into the lower Catocalinæ and some may prefer to include them there. World-wide revision is needed in all the quadrifid groups as they reach their greatest development in the tropics of both hemispheres. This brief résumé of the subfamilies leads me to re-emphasize the desirability of the use of tribal names because more degrees of groupings are clearly needed within the subfamilies to present the desired pictures.

The final subfamily given for the Phalaenidæ is the Hyblaeinæ. This follows both Hampson and all former American lists but is indubitably incorrect as was first pointed out by Forbes and has been agreed to by J. H. Comstock, Busck, Heinrich and others. The absence of a tympanum, the genitalia and the pupa are all definitely not of this family. The Hyblaeidæ must be removed

either to the Pyralidoidea (Forbes) or to the true micros (Busck and Heinrich). In a sense this makes little difference to American lepidopterists as the single species recorded must be very rare here—the reviewer has never seen one from this country.

Incidentally, it is noted that although the name of the family has been changed from Noctuidæ to Phalaenidæ, the name of the superfamily has been left as Noctuoidea. This does not seem right.

Many genera of the Phalaenidæ obviously need revision but we cannot blame the author for such present unsatisfactory listings of species. An admirable example of this is the genus *Acronicta* where what was listed as thirteen species in the 1917 check list are now grouped under two following Benjamin's revision of this section of the genus whereas the rest of the genus remains in its previous state. There are many other examples: *Raphia, Renia, Gabara,* etc., etc.

The reviewer has made no attempt to search for specific errors but might cite the following random notes: *"Panula" scindens* (#3555) should be moved to *Isogona* as suggested by Barnes and Benjamin and as confirmed by recent examination of authentic material. Under #3547, *lunearis* should be *cunearis.* Under #3563, *capticola* should be *capiticola.* Under #3695, *henloa* should be *heuloa. Umbralis* (#3700) should be transferred to *Plathypena. Citata* (#3701) should be transferred to *Anepischetos,* and also (according to Schaus) *minualis* Guenée is a prior name for this species. *Anephischetos* (p. 128) should be *Anepischetos. Sangamonia* (#3800) is a synonym or at most a Mississippi valley race of *medialis* (#3798), and *inferior* (#3799) seems no more than a southern race of *caradrinalis* (#3797). *Athyrma* (p. 124) is badly misplaced (the reviewer's fault for not suggesting a better when recording it from North America); it should go with *Massala* and *Epidromia* (p. 122).

This list, and Part II to follow, will be the constant reference for all American Lepidopterists for a long time—the bible of the amateur, the index to collections and the starting point for subsequent work on the North American fauna. It is indispensable.

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DISTRIBUTION OF THE SAWFLY (ACANTHOLYDA ERYTHROCEPHALA L.) IN NEW JERSEY

During the past summer an effort was made by the New Jersey Department of Agriculture cooperating with the Laboratory of the Division of Forest Insects of the Bureau of Entomology and Plant Quarantine at Morristown, N. J., to establish the extent of the infestation by the sawfly *Acantholyda erythrocephala* (L.).[1] Employees of the New Jersey Department made observations along with their regular work of nursery inspection and Gipsy moth scouting with the result that the scouting was not especially intensive. There are given below records of captures of this insect in New Jersey, but it should be understood that these are not complete. It is thought that the southern limit of the infestation is well defined. All of the material was determined by Mr. C. L. Griswold of the Division of Forest Insects.

Date	*Locality*	*Host*	*Collector*
July 20, 1938	Bound Brook	*Pinus strobus*	F. A. Soraci
June 23, 1938	Harbourton	*Pinus resinosa*	W. Nestle
Aug. 9, 1938	Chester	" "	F. A. Soraci
" 9, 1938	Hackettstown	" "	F. A. Soraci
" 9, 1938	Oak Ridge	" "	H. Ames
" 9, 1938	Washington	" *strobus*	H. Ames
" 23, 1938	Livingston Park	" *mughus*	F. A. Soraci
" 23, 1938	Swartswood	" *resinosa*	M. J. Raftery
" 25, 1938	Mendham	" *resinosa* and *P. strobus*	H. Ames
Sept. 2, 1938	Norwood	*Pinus resinosa*	F. A. Soraci
Aug. 30, 1938	Ringwood Manor	" "	R. E. Franklin
Sept. 23, 1938	Clinton	" "	W. Nestle
Sept. 29, 1938	Phillipsburg	" *mughus*	W. Nestle
Oct. 3, 1938	Blairstown	" *resinosa*	R. E. Franklin
Oct. 5, 1938	Fort Lee	" *strobus*	F. M. Schott
Oct. 11, 1938	South Plainfield	" *nigra*	M. Raftery
Sept. 7, 1938	Harrington Park	" *resinosa*	F. M. Schott
Sept. 8, 1938	Stockholm	" *resinosa* and *P. strobus*	H. Ames
Sept. 23, 1938	Caldwell	*Pinus resinosa* and *P. strobus*	C. E. Cobb
Sept. 22, 1938	Ridgewood	*Pinus nigra*	F. M. Schott
Oct. 19, 1938	Frenchtown	" *strobus*	W. Nestle
Oct. 19, 1938	Flemington	" *resinosa*	W. Nestle

F. A. SORACI

[1] Soraci, F. A., JOUR. N. Y. ENT. SOC., XLV 1, No. 3, 326. Sept. 1938.

NEW BUPRESTIDÆ FROM CALIFORNIA[1]

BY W. J. CHAMBERLIN, PH.D.
FOREST ENTOMOLOGIST, OREGON STATE COLLEGE

At the time *Polycesta cyaneous* was described[2] a very limited number of specimens was available although a considerable series came to hand just as the completed manuscript was being submitted for publication. These were set aside and were never critically examined until recently. Careful examination has revealed that the specimens described as *P. cyaneous* represented two quite distinct species. The males were all *P. cyaneous* as described, while some of the females were what is described below as *Polycesta tularensis*. The figure, page 44, JOURNAL NEW YORK ENTOMOLOGICAL SOCIETY, Vol. XLI, labeled *cyaneous* is correct as to the male but the female is *tularensis*. Also, another error occurs in the same article under the figure at the top of page 44; *velasco* is credited to Lec. whereas the species was described by Gory as stated on page 38.

Polycesta tularensis, new species.

Male: broadly elongate, color of the entire body bluish black more shining beneath, thorax a trifle wider than the elytra at the base. Front slightly concave with a median, elevated smooth line running from the clypeal suture to the vertex. Prothorax with a wide, rather deep median depression, along the bottom of which extends an elevated smooth, shining line; depression flanked on either side by elevated, finely granulated areas marked by scattered deep round punctures, balance of thoracic surface very irregular and with very coarse, deep punctures; sides angulated, widest just behind the middle.

Elytra with second and fourth costæ high, cristiform, smooth, others nearly obsolete. Intervals with two parallel rows of large deep punctures, interspaced and surrounded by smaller ones. Sides nearly parallel for almost two-thirds, thence rapidly converging to the tip. Elytral tips with numerous quite prominent spines and the extreme tip of each elytron terminating with a large acute spine.

[1] Published as technical paper No. 267 with the approval of the director of the Oregon Experiment Station. A contribution from the Dept. of Entomology.

[2] 1933 Chamberlin, W. J. A synopsis of the genus Polycesta, etc. Journ. N. Y. Ent. Soc. XLI pp. 32–45.

Prosternum elevated, shining, with a few scattered shallow punctures between the coxæ, first transverse abdominal suture sinuate so that the center is bowed cephalad. Last ventral quite triangular, tip with a very faint indentation and a short elevated keel extending nearly one-half the distance to the base. Length 15–20 mm.; width 6.5–8 mm.

Female as described for *Polycesta cyaneous* but a series shows the size to be much larger on the average. The majority are from 20 to 22 mm. in length and 8 to 9 mm. in width.

Type locality: Springville, Tulare County, California, August—collected by F. T. Scott. Type and allotype in author's collection, paratypes in Mr. Scott's collection and in collections of the California Academy of Science.

The species is quite near *P. cyaneous* but is readily distinguished by its larger size, distinctly bluish color, angulated thorax, the smooth median line on the front, the median line of the prothorax and the acuminate spine at the tip of each elytron; all serve to distinguish this from other species of the genus.

Since the female *P. cyaneous* previously described is in reality the female of *tularensis* the following descriptions of the allotype *P. cyaneous* is given.

P. cyaneous female allotype: Color dull rusty black, shape same as in the male; sides of thorax rounded, slight median depression without line, front flat without elevated line. Scutellum very prominent, bulbous, shining black; elytra striate punctuate as in the male, spines at tip of elytra smaller and extreme tip without prominent acuminate spine.

Last ventral broadly, evenly, rounded, length 14 to 18 mm.; width 5.8 to 7 mm. Type locality same as for the male.

HIPPOMELAS

As now constituted (Leng's Catalogue of the Coleoptera) this genus contains rather a heterogeneous group of species. The characters heretofore separating *Hippomelas* and *Gyascutus* being either sexual, variable, or very minute it is perhaps best to leave the genus as now constituted, until someone who has access to the types will revise the entire groups.

The following new species is very distinct.

Hippomelas pacifica, new species.

Male: color dull black with only a very faint tinge of brown. Body elongate, sides quite parallel, thorax roughly, deeply sculptured, the irregular

elevations smooth and jet black; depressions rather coarsely punctate with a faint bronze tinge. Sides of elytra nearly parallel three-quarter, thence rounded, tips slightly truncate. First two striæ faintly evident. Elytra distinctly transversely carinulate in the humeral region, faint indication of serrations near tip. Dorsal surface with scattered, very fine pubescence. Ventral surface with scattered, longer, silver pubescence—Prosternum elevated roughened with large pores. Last ventral truncate. Front tibia curved; tarsi of all legs about 4/5 as long as tibia.

Antennæ extend to middle of the thorax, first segment almost as long as two and three combined, first 3 quite cylindrical, serrate after third with segment 4 distinctly wider than any of the others. Last segment entire with a few bristle-like hairs. Length, male 10.7 mm.; width 3.6.

Female: color dull black with distinct greenish reflections. Thorax as in male, sub-equal in width to elytra. Elytra quite parallel two-thirds then gradually narrowed, serrate near tips, which are slightly indentate with two small lateral teeth.

Antennæ as in male except that the terminal segment has the process common to other species of this genus.

Prosternum very much roughened and dull in color. Venter with faint greenish tinge.

Front very much roughened in both sexes, carina above antennæ prominent and sharp. Antennæ inserted very close to the eyes. Female, length 13.9 to 19 mm.; width 4.9 to 6 mm.

The smaller size, dull color, roughened thorax and prosternum and the transverse carinulate elytra all serve to distinguish this species from all others of the genus, none of which the new species resembles.

Described from four specimens, one male and three females as follows:

Type male, Rolinda, Fresno County, California, VI–12–27.

Allotype and paratype, Mendota, Cal., VII–7.

Another female collected at Kettleman, Kern Co., California, on sage brush, VI–11–33.

All specimens were submitted by Roy S. Wagner who has the paratypes.

NOTES ON SOME CICADAS IN VIRGINIA AND WEST VIRGINIA

BY H. A. ALLARD

On July 10, 1932, the writer climbed to the top of Mary's Rock in Rappahannock County following the trail from Panorama. Near the top, around 3500 feet, a solitary cicada was singing in some dwarfed oak trees and low enough to be within reach. It was carefully approached and caught by a quick grasp of the hand. This diminutive little cicada proved to be *Okanagana rimosa* Say, the identification being made by Mr. Paul Oman, of the U. S. National Museum, and confirmed by Dr. Wm. T. Davis, of Staten Island, N. Y. While its singing was distinctive, unfortunately notes made at the time describing the character of its song cannot now be located.

It may be stated, however, that this cicada has not hitherto been reported from Virginia, although a key to the genera of Virginia cicadas by Wm. T. Davis in his paper "An annotated list of the Cicadas of Virginia with description of a new species" (JOURNAL NEW YORK ENTOMOLOGICAL SOCIETY, Vol. 30, 1922), included the genus *Okanagana,* since he thought it probable that it would be found in the mountains.

The range of *Okanagana rimosa* is one of the widest of all our North American cicadas, extending from Nova Scotia to British Columbia south to New York and Pennsylvania in the east and Nevada in the west.

It is possible that this cicada is not common even in the mountains of Virginia, for the writer has not since heard any song which could be assigned to this species, although large sections of the mountain areas of the Blue Ridge, the Massanutten and the Alleghenies have been traversed at all seasons of the year.

Tibicen robinsoniana Davis

The writer for some years had heard this cicada singing in various localities in Virginia before he was able to secure a speci-

men and establish its identification. As Davis has suggested in his paper, above referred to, the song of this cicada has an Orthopteran character. As a matter of fact the writer on his first acquaintance with its singing believed he had located a group of katydids which he had never heard in song before, and discussed the matter on this basis with the late Mr. A. N. Caudell, of the U. S. National Museum. However, in later years a glimpse of a singer that flew when its song terminated indicated that these puzzling musicians were cicadas.

On August 14, 1937, the writer traversed the high sharp ridge of the Massanutten range which takes its origin from the Fish Hatcheries in Powells Fort Valley and extends southward. The crest of this ridge here separates Shenandoah County from Warren County on the east and has an altitude of about 1800 feet. The cicadas *Tibicen robinsoniana* were singing noisily throughout this area during the hot sunny hours of the day. The next day a trip was made up the steep slopes of the southernmost terminus of Short Mountain in the Massanutten range. This ridge lies just east of the little town of Mount Jackson in Shenandoah County. The day was hot and sunny, and these cicadas were singing in small groups or as solitary individuals throughout the deciduous oak woods covering this slope. They appeared to be especially noisy in the zone between 2000 to 2500 feet here. Until this time the writer had had no success in securing one of these wary cicadas, but on this day on Short Mountain a well-directed throw with a club at a musician singing on an oak limb perhaps 20 to 25 feet from the ground so stunned the creature that it fell fluttering to the gound and was quickly taken. This was identified by Mr. Paul Oman as *Tibicen robinsoniana* a name applied by Mr. Wm. T. Davis in 1922, in the paper previously referred to, from material taken in Nelson County, Virginia. Until this time this species had somehow been overlooked by collectors and taxonomists.

Since its characterization by him as a new species in 1921, *T. robinsoniana* has been taken in Missouri (1923) and in Tennessee (1926).

This interesting cicada appears to be rather generally distrib-

uted in Virginia. It has been reported from Nelson County and Frederick County near Winchester by Mr. Davis. The writer has heard its unmistakable song in colonies near Warrenton, Fauquier County, and at various points in Powells Fort Valley and high up along the steep ridges of the Massanutten range, all in Shenandoah County. This cicada also extends its range westward across the Great Valley into the high Alleghenies of West Virginia, where the writer made an unsuccessful attempt to capture a singer on August 20, 1937, on a small oak tree near the entrance to Gunpowder Cave in the Smokehole country, Pendleton County, at the 2500 foot contour. He is reasonably sure he heard individuals and small colonies singing at several points around Clarendon in Arlington County in June, 1937.

While this cicada cannot be considered common judging from the prevalence of singing colonies and individuals, it is probably rather widely distributed in Virginia; just what its distribution is in West Virginia cannot be told from the single record made by the writer in the mountainous area of Pendleton County.

The writer's observations of this cicada incline to the belief that it is more abundant in or near mountainous territory, or in the higher Piedmont.

A few words may not be amiss concerning its distinctive song, for once heard and fixed in memory it can never be confused with any other cicada song. As Mr. Davis has written, there is something strongly Orthopteran in its quality and delivery. To me it suggests at a distance the lisping notes of some katydid with an intermittent song rather than the song of a cicada. It is in reality a continuous song when heard near at hand, each louder pulsation, the "Zape," "Zape" of Davis, being connected by a series of minor ticks or rasps, so that it can be written as ZAPE z-z-z-z-ZAPE z-z-z-z, continued for several minutes. The minor ticks of its song appear to follow a strong muting of the ZAPE almost to the point of extinction by closure of the opercula brought about by downward movements of the abdomen in the singing of cicadas.

The minor ticks connecting the louder pulsations of the song of *Tibicen robinsoniana* can only be distinguished near at hand. At a distance one hears only the series of major pulsations leading

one to believe that it is a strictly intermittent song like that of some species of Neoconocephalus, when in reality it is not.

Tibicen lyricen var. *engelhardti* Davis

On August 22, 1937, the writer found a dead female of this species on the ground near the entrance to Gunpowder Cave on Cave Mountain, Pendleton County, West Virginia, at about 2500 feet. This appears to be well distributed in the mountain areas of Virginia.

ON A CHARACTERISTIC SOMATIC MODIFICATION INDUCED BY ADVERSE ENVIRONMENTAL CONDITIONS IN DROSOPHILA

By C. P. Haskins and E. V. Enzmann
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It has long been known that the time interval required for the metamorphosis of cyclorrhaphic Diptera, which is constant under standard conditions and characteristic for each species, varies considerably with changing environmental conditions. The variations of this interval with temperature have been investigated repeatedly and found to be of the same order of magnitude as the rate changes of many other biological processes with temperature changes.

The fluctuations in time required for the metamorphoses of these insects, induced by such agents as scarcity of food, are of a different order of magnitude than either those due to temperature variations or genetic differences, and are generally much larger. In our own experiments we were able to extend the time required for a complete cycle from egg to imago in *Drosophila* to 55 days, as compared with the average time of 9 to 12 days required under favorable conditions (20 to 50 larvæ per pint bottle of corn meal-molasses-agar-yeast culture at 26° C.). The effect is definitely proven as due to lack of food by collateral experiments in which larvæ were reared on filter paper to which a measured amount of food was added at intervals in the form of known quantities of yeast cells. Experiments with infected cultures, where the growth of *Aspergillus Penicillium,* or bacteria interferes with the multiplication of yeast cells, are of lesser value, because the fly larvæ consume mycelia, spores, and bacteria in large quantities and in this way overcome to some extent the scarcity of yeast food. Furthermore larvæ fed on such abnormal diet produce imagos showing various types of morphological abnormalities other than the one reported below.

The most convenient method next to that of rearing flies on

filter paper is that of increasing the number of eggs set out to hatch in a given culture. In a test series made by this method it was found that the average length of time required for metamorphosis was roughly proportional to the egg density in culture at the start.

At very high egg densities (over 2000 eggs per culture) a small percentage of individuals completed metamorphosis in normal time, another small fraction with a small delay, while about 90 *per cent* lived abnormally long as larvæ, some as much as 60 days, or longer than the normal average life span of *Drosophila* (*cf.*, Crozier and Enzmann, 1937). Such long-lived larvæ were slowed down in their development and cell differentiation. Thus the first instar and all the internal changes which ordinarily take place within 12 to 24 hours after hatching from the egg, were found delayed for as long as 2 weeks. During the later instars the underdevelopment of the fat body was the most conspicuous sign of lack of nutrition. If the larva pupated at all both pupa and imago were abnormally small.

Superficially the emerging flies were normal and they produced offspring of normal size and structure. A closer examination however revealed that nearly half of all flies produced after a period of metamorphosis exceeding 30 days had abnormal eyes.

The abnormality is a characteristic and constant feature and consists of the destruction of the normal hexagonal pattern of the facets, a diminution of facet number leaving irregular empty spaces on the eye rim, and finally the production of a number of abnormally large facets of deep red color. The term "blistered eye" has been applied to this peculiar somatic modification.

We are at present unable to give an explanation of the processes which lead to the production of blistered eyes. The deep red color of the enlarged facets in wild stock, as compared with the lighter red in normal-sized facets, suggests that the process of their formation is similar to the formation of "twin-spots" in *Drosophila* eyes (Haskins and Enzmann, in press), which is probably due to non-disjunction or similar processes as has recently been discussed by Jones (1937) who investigated twin spotting in *Zea mays*. The enlargement of the facets in our starved flies suggests polyploidy. In the somatic mosaics of diploid and tetra-

ploid cells described in plant material by many observers, the tetraploid cells are often found to be of larger size. No definite statement can be made regarding polyploidy in blistered eyes until chromosome counts are available.

The problem is of sufficient importance to be investigated further. Two points especially need further research: (1) does artificial delay of otherwise relatively rapidly dividing cells induce a tendency to chromosomal aberrations in other forms where direct examination of the chromosomes is easy and rapid; (2) would it be possible to induce the blistered eye modification by such an agent as colchicine, which is known to induce polyploidy in plant material?

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ADDITIONS TO THE NEW YORK STATE LIST OF TABANIDÆ

By L. L. Pechuman
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Since the appearance of "A List of the Insects of New York"[1] in 1928, many new records in the various groups of insects have been secured. This is especially true of the Tabanidæ. The writer has made extensive collections of this group in western, central, and southeastern New York, and has secured many specimens collected in other parts of the state. A total of about two thousand specimens were collected and examined.

Not all new localities for the various species are given in the following list. Only those localities which extend or fill in gaps in the range of the species are included. All species new to the state are indicated by an asterisk (*). The collector's name is in italics and follows the locality. Abbreviations for the various collectors are: F. C. Baker, *Bkr*; S. Bettini, *Bti*; F. S. Blanton, *Blant*; W. G. Bodenstein, *Bodstn*; C. R. Crosby, *Cy*; H. Dietrich, *Dt*; R. H. Flower, *Flr*; J. G. Franclemont, *Frclt*; H. C. Hallock, *Hlk*; K. V. Krombein, *Krom*; C. G. Lincoln, *Lcn*; C. E. Palm, *Pm*; L. L. Pechuman, *Pech*; W. D. Sargent, *Sgt*; C. Tongyai, *Tongyai*; H. K. Townes, *Townes*; F. W. Trevor, *Trev*. The cooperation of all collectors is gratefully acknowledged.

All species of the genus *Tabanus* on which new records are based were determined by Dr. Alan Stone, and certain changes in nomenclature are based on Dr. Stone's manuscript notes.[2] The writer greatly appreciates this assistance. Determinations in all other genera are by the writer.

[1] Leonard, M. D. A list of the insects of New York. Cornell Univ. Agr. Exp. Sta. Mem. 101. Tabanidae: 754–758. 1928.

[2] Since this paper was written Dr. Stone's revision of the Nearctic Tabaninæ (U. S. D. A. Misc. Pub. 305. 1938.) has appeared. Stone gives three species of *Tabanus* not previously recorded from New York, *frontalis* Walk. from Peru, *sublongus* Stone from Ithaca, and *vivax* O. S. (not of authors) from Trenton Falls. He also places in the genus *Atlyotus* O. S. four New York species previously placed in *Tabanus, bicolor* Wied., *ohioensis* Hine, *pemeticus* John., and *thoracicus* Hine.

Stonemyia Brennan

Stonemyia Brennan replaces *Buplex* Austen of the 1928 list.

S. tranquilla (O. S.). Ithaca, *Pech.*

Goniops Aldrich

G. chrysocoma (O. S.). Allegany St. Pk., *Krom.*

Chrysops Meigen

C. æstuans Van der Wulp. Replaces *C. mœrens* Walk. The specimens from N. Fairhaven, Lakeside Pk., and Olcott on which some of the 1928 records were based are *C. callida*; specimens on which the remaining locality records for this species in the 1928 list were based were not available for study. Additional records are: N. Fairhaven, *Bkr*; Canadarago L., *Townes.*

C. callida O. S. Lockport, *Pech*; Oak Orchard Swamp, *Pech*; Bear Mt. St. Pk., *Pech*; Patterson, *Pech*; Yonkers, *Pech*; Babylon, *Blant*; Belmont Lake St. Pk., *Bodstn.*

C. carbonaria Walk. Babylon, *Blant.*

C. delicatula O. S. Oswego, *Lcn & Pm*; Belmont Lake St. Pk., *Bodstn*; Babylon, *Blant*; Islip, *Blant.*

C. dimmocki Hine. Babylon, *Blant.*

C. excitans Walk. Constantia, *Trev*; Artist's Brook, *Dt*; Bolton Landing, *Tongyai.*

C. frigida O. S. Connecticut Hill, *Hlk*; Constantia, *Trev*; Childwold, *Dt*; Patterson, *Pech.*

C. fuliginosa Wied. Pelham Bay Pk., N. Y. City, *Dt.*

C. geminata Wied. Lockport, *Pech*; Patterson, *Pech*; Babylon, *Blant.*

C. inda O. S. Lockport, *Pech;* Chafee, *Frclt;* Oswego, *Krom;* Constantia, *Trev;* Babylon, *Blant.*

C. lateralis Wied. Crystal Lake, Catt. Co., *Frclt;* Connecticut Hill, *Hlk*; Oneonta, *Townes*; Felt's Mills, *Bodstn.*

C. lugens Wied. Mahopac Falls, *Pech.* Brewster, *Pech.*

C. mitis O. S. Labrador Lake, *Pech*; McLean, *Pech*; Malloryville, *Pech;* Canadarago Lake, *Townes;* Mt. Whiteface, *Dt;* Artist's Brook, *Dt.*

C. mœcha O. S. Lockport, *Pech*; Gasport, *Pech*; Oak Orchard Swamp, *Pech*; Patterson, *Pech*; Armonk, *Pech.*

C. montana O. S. Tonawanda, *Krom*; Bear Mt. St. Pk., *Pech*; Babylon, *Blant.*

*C. *pikei* Whit. Belmont Lake St. Pk., *Bodstn.*

C. pudica O. S. Babylon, *Blant*; Riverhead, *Blant.*

C. sackeni Hine. Lockport, *Pech*; Monroe, *Pech*; Shokan, *Townes*; Bear Mt. St. Pk., *Pech*; Patterson, *Pech.*

*C. *shermani* Hine. Lake Sacandaga, *Sgt*; Hancock, *Townes*; Bear Mt. St. Pk., *Pech;* Mt. Ivy, *Pech;* Putnam Co., *Pech;* Allegany St. Pk., *Townes.*

C. sordida O. S. Artist's Brook, *Dt.*

C. striata O. S. Lockport, *Pech*; Oak Orchard Swamp, *Pech*; Babylon, *Blant.*

C. univittata Macq. Chafee, *Frclt*; Rochester.

Tabanus Linnæus

T. actæon O. S. Patterson, *Pech.*

T. affinis Kby. Silver Bay, *Tongyai*; Poughkeepsie, *Townes*; Patterson, *Pech.*

T. carolinensis Macq. Ithaca, *Pech*; Belmont Lake St. Pk., *Bodstn.*

T. catenatus Walk. Replaces *T. orion* O. S. Canajoharie, *Townes*; Hancock, *Townes*; Bronx, N. Y. City, *Pech.*

T. cinctus Fab. Troy, *Flr.*

T. coffeatus Macq. Shokan, *Townes.*

T. epistates O. S. Buffalo, *Krom*; Lockport, *Pech*; Monroe, *Pech*; Arthursburg, *Pech.*

T. fairchildi Stone. Replaces *vivax* of authors, not Osten Sacken. Peru, *Dt.*

T. illotus O. S. Malloryville, *Pech*; Churubusco, *Dt.*

*T. *lineola* Fab. var. *scutellaris* Walk. Oswego, *Krom*; Peru, *Dt.*

*T. *metabolus* McD. McLean.

T. minusculus Hine. McLean, *Hlk.*

T. nigrescens P. d. B. Lockport, *Pech.*

T. nudus McD. Black Brook, *Dt.*

*T. *pemeticus* John. Lake Tear on Mt. Marcy, W. T. M. Forbes.

T. reinwardtii Wied. Lockport, *Pech*; Pelham Bay Pk., N. Y. City, *Pech.*

T. recedens Walk. Bronx, N. Y. City, *Pech.*

**T. sackeni* Fairch. Ithaca, *Pech*; Poughkeepsie, *Townes*; Yonkers, *Pech.*

T. sparus Whitn. Belmont Lake St. Pk., *Bodstn.*

T. stygius Say. Lockport, *Pech*; Poughkeepsie, *Townes.*

**T. subniger* Coq. Ithaca, *Bti*; Oneonta, *Townes.*

T. sulcifrons Macq. Crystal Lake, Catt. Co., *Frclt & Pech*; Chafee, *Frclt*; Lake Mohonk, *Townes.*

T. superjumentarius Whitn. Bear Mt. St. Pk., *Pech*; Yonkers, *Pech.*

T. thoracicus Hine. McLean, *Hlk.*

T. trepidus McD. Ithaca; Oswego, *Krom*; Armonk, *Pech.*

T. trispilus Wied. Lockport, *Pech*; Oswego, *Krom*; Poughkeepsie, *Townes*; Armonk, *Dt.*

**T. typhus* Whit. Ithaca, *Cy*; Oswego, *Lcn & Pm*; Rockland Co.

T. vicarius Walk. Replaces *T. costalis* Wied.

INDEX TO NAMES OF INSECTS AND PLANTS IN VOLUME XLVI

Generic names begin with capital letters. New genera, subgenera, species, subspecies, varieties and new names are printed in italics.

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